RAE-9351/2-1

WORK PLAN FOR CHARACTERIZATION OF RADIOACTIVE CONTAMINATION 316 EAST ILLINOIS STREET, CHICAGO, ILLINOIS

FOR: Chicago Dock and Canal Trust

Project Manager: V.C. Rogers
Assistant Project Manager: D.E. Bernhardt

September 1993

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1. INTRODUCTION

The U.S. Environmental Protection Agency (EPA) and Illinois Department of Nuclear Safety (IDNS) measured elevated gamma radiation levels on portions of the 316 East Illinois Street site in Chicago, Illinois. Property records indicate that Lindsay Light Company leased the site from about 1915 to 1932. Lindsay Light Company made lantern mantels containing thorium, but no specific process activities have been documented for this site. The 316 East Illinois Street site is herein referred to as "the property" or the 316 East Illinois site.

1.1 OBJECTIVE

This Work Plan describes the activities for characterizing the radioactive materials present at the 316 East Illinois Street site. The characterization includes determining the radioactive materials that are present, the concentrations of the radioactive materials, and the RCRA (Resource Conservation and Recovery Act) characteristics as defined in 40 CFR 261. Groundwater samples will be obtained from four shallow monitoring wells installed on the site during a due diligence investigation in 1992.

The Field Investigation Plan, Health and Safety Plan, and Quality Assurance Project Plan are incorporated in the Work Plan.

1.2 REPORT CONTENT

This work plan provides information from prior investigations performed at the property, presents a Field Investigation Plan for characterizing the apparent radioactive contamination at the site, and provides Health and Safety and Quality Assurance Project Plans to support the investigation work.

Chapters 1 through 5 provide the basic Work Plan. Appendix A is a copy of the draft Administrative Order by Consent presented by EPA. The detailed Field Investigation Plan, Health and Safety Plan, and Quality Assurance Project Plan are given as Appendices B, C, and D, respectively. Chapter 1 presents background information on the property. Chapter 2 describes the scope of work, including project management and the procedures for modification to this Work Plan. Chapter 3 provides a brief overview of the Health and Safety Plan and Chapter 4 provides an overview of the Quality assurance/Quality control. The schedule and project deliverables are given in Chapter 5. Appendix E includes additional historic information on the 316 East Illinois site.

1.3 PROJECT DESCRIPTION AND BACKGROUND

The Chicago Dock and Canal Trust (Chicago Dock) property, at 316 E. Illinois, extends between East Illinois Street on the south to Grand Avenue on the north. It is bounded by Columbus Drive on the west and Mc Clurg Court on the east. Figure 1-1 shows the general layout of the site. Figure 1-2 is a location map, indicating the location of the property within the state of Illinois and the City of Chicago.

The U.S. Environmental Protection Agency (EPA) measured elevated gamma radiation levels on portions of the site and has designated the site as Lindsay Light II. The property, which was leased to Lindsay Light prior to about 1933, is presently undeveloped and has been used as a parking lot in recent years. The lot, operated by General Parking Company, is paved with asphalt and has guard rails to border the parking lot.

Chicago Dock and Canal Company was founded in 1857. Chicago Dock and Canal Trust, the direct successor of Chicago Dock and Canal Company, is a real estate investment trust formed in 1962. Both companies are included in the reference to "Chicago Dock," Chicago Dock records indicate that the property was leased to Lindsay Light from about 1915 to 1932. Information from historic record searches, indicates that prior to 1915, there were several industrial and manufacturing operations on the site. These activities, dating back to about 1900, apparently included a metal polishing plant, a carbonic acid manufacturer, and a lubricating oil plant with underground storage tanks (STS92). These records also

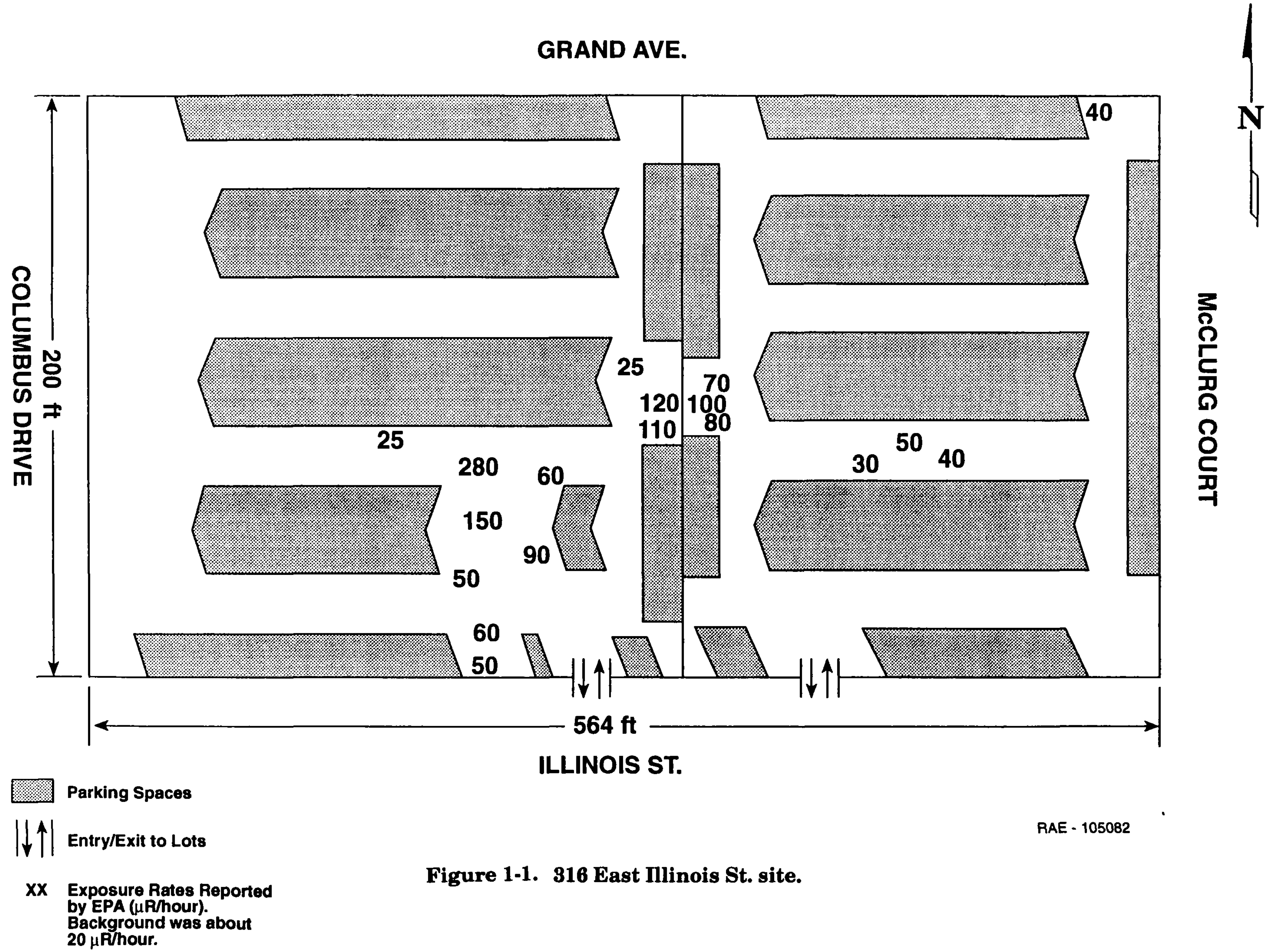

Figure 1-1. 316 East Illinois St. site.

Figure 1-2. 316 East Illinois location map.

indicate that the property from 216 to 322 East Illinois was rented by Cooper's Stable prior to 1913 till 1914 or later. A two-story building on the property housed a stable for horses and wagons and a blacksmith shop.

In 1914 the Cooper Stable was divided in half, from east to west. The south half, fronting on Illinois at 316-322 was leased by Lindsay Light. Chicago Dock's records indicate that Lindsay Light made rent and tax payments on this property until about 1932. The building was demolished around 1933, which is consistent with the cessation of rent payments by Lindsay Light.

Review of property records indicates that Lindsay Light probably performed its primary manufacturing operations in this area of Chicago at 161 East Grand Ave, about one-quarter mile west of the property. The perception is that the manufacturing operations were performed at 161 East Grand Ave, and that the 316 East Illinois site was used as a warehouse site and as a stable to provide support services for transporting material to and from the main site.

Appendix E provides additional information about the Lindsay Light operations and background information on the site.

1.3.1 Prior Investigations

There are records of two site investigations at the 316 East Illinois property. In mid 1992 STS Consultants Ltd. performed a due diligence investigation for POWER/CRSS related to the proposed purchase of property for the Proposed Northwestern Memorial Hospital Facility Redevelopment Site. In mid 1993 the EPA and IDNS performed a radiation survey on the site, based on information from the review of historic land ownership records which indicated that Lindsay Light had operations at the site.

1.3.1.1 STS Site Investigation

STS Consultants Ltd. (STS92) performed a site investigation at the property in mid 1992. The investigation included the property between East Illinois Street Grand Avenue, and Columbus Drive and McClurg Court. These are also the property boundaries for the 316 East Illinois site (see Figure 1-1).

The STS site investigation included digging several investigation test pits, installing four shallow groundwater monitoring wells, and drilling numerous borings to obtain soil samples. STS reported that petroleum is spread over an area of approximately 24,000 square feet of the general site. The presence of petroleum appears to be vertically centered on the water table at a depth of about 13 ft, and extends about 4 ft below and above the water table. However, there was no measurable thickness of petroleum residue floating on the water table in the monitoring wells. A figure indicating the sampling locations and tables providing a summary of the results are given in Appendix E.

The following items summarize the results of the STS investigation:

- No radioactive monitoring was performed and no samples were specifically analyzed for the presence of radioactive materials.
- Petroleum hydrocarbons (TPH) and polynuclear aromatic hydrocarbons (PNA) were present in many samples. The detection of volatile organic compounds ((VOC) xylene and/or ethylbenzene) indicates the presence of petroleum or petroleum products; probably diesel, heating, or heavy lubricating oil. Benzene and toluene were not detected in the soil or water samples. The measured concentrations of total xylenes and ethylbenzene, the other constituents of BTEX, were less than 1 ppm (parts per million or mg per kg).
- Trace levels of several chlorinated solvents compounds (e.g., tetrachloroethene, trichloroethene, and tetrachloromethane) were detected in three test pit samples. However, the concentrations were at the trace level, and were not present in boring or groundwater samples. The identified concentrations were less than 1 ppm.
- Check results re PCB in soil and groundwater. Check metals in soil.
- No detectable levels of PCBs were observed in the soil samples. Barium was the only RCRA heavy metal with an elevated concentration in the soil samples. The concentration in boring B-128 was 12 ppm of barium. The

other concentrations, for samples where metals were analyzed, were about 1.1 ppm of barium or less.

- Total lead and chromium concentrations in water exceeded the EPA MCLs in three of the monitoring well samples. The concentrations of total lead were 0.5, 1.8, and 2.9 ppm in samples from wells MW-128, MW-130, and MW-131, respectively.

- The concentrations of TPH and PNAs ranged up to over 15,000 ppm.

1.3.1.2 Radiation Investigations by EPA and IDNS

EPA and IDNS performed radiation surveys at several former Lindsay Light sites in the area of Chicago near the subject property in mid 1993. On June 1, 1993, they performed a radiation survey at the 316 East Illinois site and discovered the presence of elevated gamma exposure rates. The information from this survey is given on Figure 1-1.

The records for the past use of the property indicate that the elevated radiation measurements may be due to residuals of material from Lindsay operations.

1.3.2 Administrative Order by Consent

On July 15, 1993, EPA provided a draft Administrative Order by Consent (AOC) to Baker & McKenzie, legal council for Chicago Dock. The AOC requested Chicago Dock to prepare a Work Plan for site investigations, and subsequent to obtaining EPA approval of the Work Plan to implement the Plan. The draft AOC is given in Appendix A. This Work Plan is in response to the AOC.

2. SCOPE OF WORK

This work plan describes the activities for characterizing the 316 East Illinois property. The field activities will include performing radiation surveys, obtaining subsurface samples, collecting groundwater samples and analysis of the samples.

2.1 PROJECT MANAGEMENT

The project management organization is given in Figure 2-1. The work will be performed under EPA oversight. Ms. Verneta Simon, of the EPA Region 5 Office, Emergency and Enforcement Response Branch, Response Section III, will be the EPA On-Scene Coordinator. Dr. Vern C. Rogers, of Rogers and Associates Engineering (RAE) is the Project Manager, and the Project Coordinator. After approval of the Work Plan, Communications between EPA and representatives of the property, concerning this Work Plan, will be coordinated by Ms. Simon and Dr. Rogers. Any designation of alternates by these individuals will be authorized in writing.

Dr. Rogers, as the Project Manager, is responsible for ensuring full implementation of the Work Plan. The following identifies the key individuals and their responsibilities:

Project Manager, Vern C. Rogers: Responsible for overall conduct of all project work, establish project schedules, budget, and priorities; approve the recommendations of Project QA Officer and the QA requirements for the project; provide oversight of Field Investigation; approve documents prior to their distribution and use.

Assistant Project Manager, David E. Bernhardt: Support Project Manager in accomplishing his responsibilities. The Assistant Project Manager is authorized to act as the Project Manager when the Project Manager is not available.

Field Investigation Manager, David E. Bernhardt: Responsible to recommend to the Project Manager procedures for the field investigation activities, direct

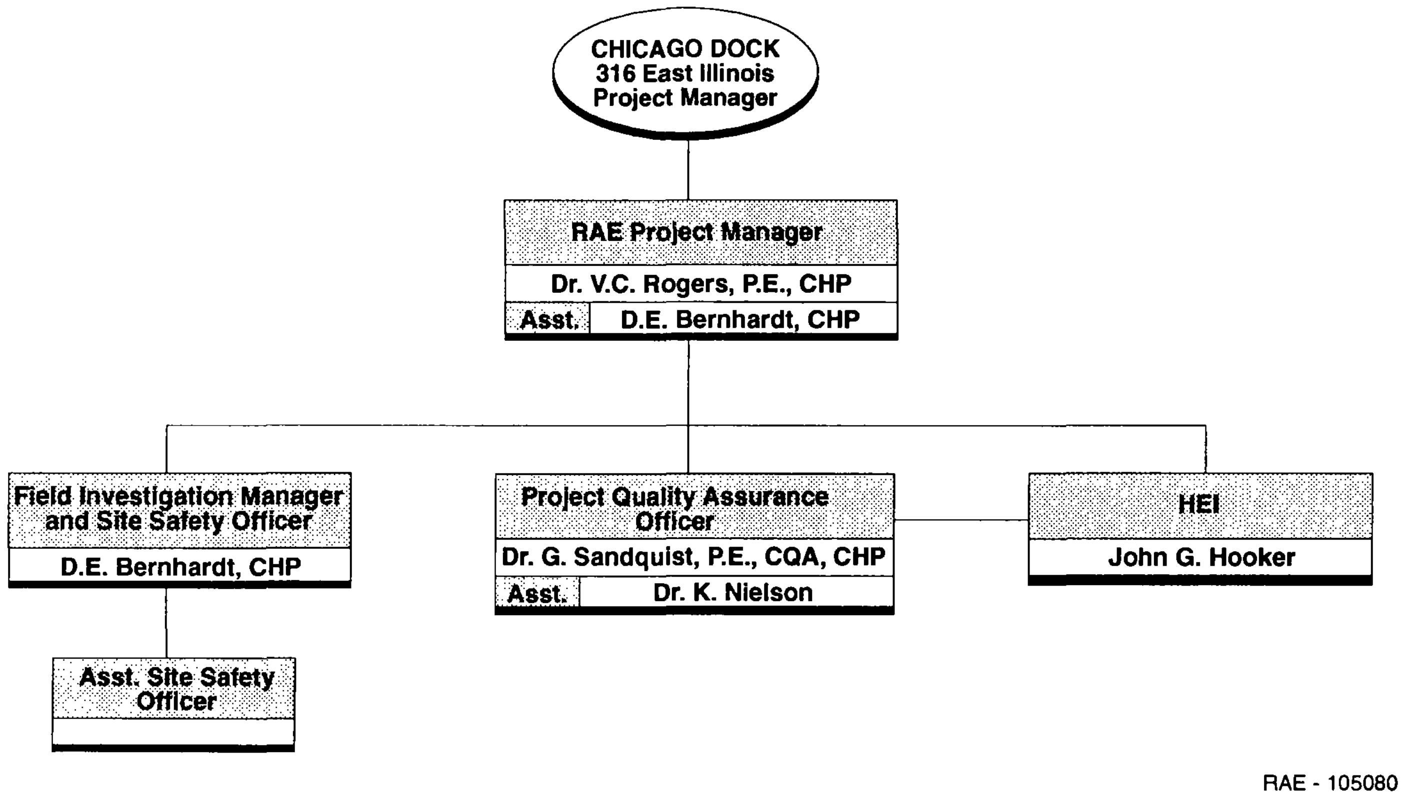

Figure 2-1. 316 East Illinois Project organization chart.

and coordinate field investigation activities, ensure proper data collection and application of sampling techniques.

Project Quality Assurance Officer, Gary, M. Sandquist: Responsible to the President of RAE to ensure proper application of quality assurance (QA) requirements, procedures, and practices for project. Review, evaluate, interpret, and define the application of QA requirements, standards, and guidelines for the project; conduct or direct QA audits, surveillance, and other related activities; and certify the completion of all corrective actions.

Assistance Project Quality Assurance Officer, Kirk K. Nielson: Support the Quality Assurance Officer as necessary.

HEI, John G. Hooker: Designate HEI personnel to provide required assistance for the project.

2.1.1 Revisions to Work Plan

The Work Plan, after approval by Chicago Dock and EPA becomes the official plan for performing the characterization of the property and preparation of required reports. Changes in the Work Plan require the written concurrence of representatives of Chicago Dock, EPA, and the RAE Project Manager. If changes are required during the field work, modifications can be written in the margin of the official on-site copy of the Work Plan (maintained by Field Investigation Manager) initialed by the EPA On-Scene Coordinator and the Field Investigation Manager. Furthermore, any such changes shall have been verbally approved by the Project Manager. Written validation of any such changes shall be signed by Chicago Dock, the EPA On-Scene Coordinator, and the Project Manager within 10 working-days of their initiation.

2.2 WORK TO BE PERFORMED

The Field Investigation will include land surveying, radiation monitoring, drilling borings, gamma logging borings, subsurface sampling from borings, collecting groundwater samples, and analysis of samples. The following items briefly describe these activities:

a. Perform land survey to provide a definitive basis for locating radiation survey and sampling locations. The survey will provide both coordinates and elevation bench marks.

b. Perform external gamma radiation survey on 3-meter grid lines over the site. The radiation survey will be performed with 1-inch NaI detectors and will be cross referenced to either a tissue equivalent dose-rate instrument (e.g., HP 1010) or other instrument measuring true exposure rate in microroentgen per hour or effective dose equivalent.

c. Drill approximately 5 boreholes for collecting samples of subsurface solids. The borings will be placed in the suspected areas of contamination and at a minimum of one background location to determine subsurface radiation levels and obtain samples of the subsurface materials. Gamma logs will be taken in the boreholes using a NaI gamma radiation detector.

d. Collect samples from the borings and analyze the samples for radionuclides in the uranium and thorium decay chains and RCRA characteristics. Splits of these samples will be made available to EPA. Samples will be collected and managed under chain-of-custody procedures.

e. Collect water samples from the four shallow groundwater monitoring wells previously installed by STS Consultants Ltd., as part of investigation in 1992. The water samples will by analyzed for uranium, radium-226 and -228, and the metals listed in 40 CFR 141.11 of the EPA Primary Drinking Water Regulations.

2.2.1 <u>Field Investigation Plan</u>

The complete Field Investigation Plan is given as Appendix B. The following sections describe the basic tasks in the investigation plan.

2.2.1.1 Site Survey

A land survey will be performed by surveyors licensed in the State of Illinois. The survey will provide fixed points for both coordinates and elevation. Fixed survey pins will be placed at the four corners of the property and near the center of the property, and coordinates for the existing monitoring wells will be determined. The survey will provide sufficient detail for providing an accurate 3-m by 3-m grid for performing the gamma survey.

Sufficient bench marks will also be provided for determining future sampling locations. If necessary the site will be re-surveyed after sampling to provide the coordinates for sampling locations.

2.2.1.2 Radiation Survey of Site

An external gamma radiation survey will be performed of the property. The survey will be extended into the surrounding right-of-ways if there are indications of elevated gamma exposure rates in these areas. The survey shall not be extended onto private property not owned by Chicago Dock.

A survey grid, based on 3 meter center points will be laid out. The survey will be performed using 1-inch NaI detectors, at a height of 1-meter above the surface. The survey results will be observed between grid intersections and fixed measurements will be taken at grid intersections. The observation of readings between grid points will ensure the identification of locations with the highest exposure rates. More detailed surveys (e.g., at a minimum of 1-meter spacings) will be made for the three general areas with the highest exposure rates and/or in areas where the exposure rate is greater than 200 uR/hr. Detailed surveys will be performed in the three areas with the highest gamma exposure rates to ensure the locations of the highest exposure rates are identified. Figure 2-2 provides an example of where fixed measurements shall be made and the survey of an area where one of the maximum exposure rate measurements is identified.

Surface measurements (detector at surface level) will be made at 10 or more of the grid points where the highest gamma exposure rates were measured. The areas where the three highest gamma exposure rates are measured will also be surveyed to ensure measuring the highest surface exposure rate.

Measurements will be made at 10 or more of the gamma measurement grid points with a tissue equivalent instrument (e.g., Health Physics Model 1010) to provide a correlation for estimating the air-kerma (i.e., dose in rad) and other dosimetry units (e.g., effective dose equivalent (EDE)).

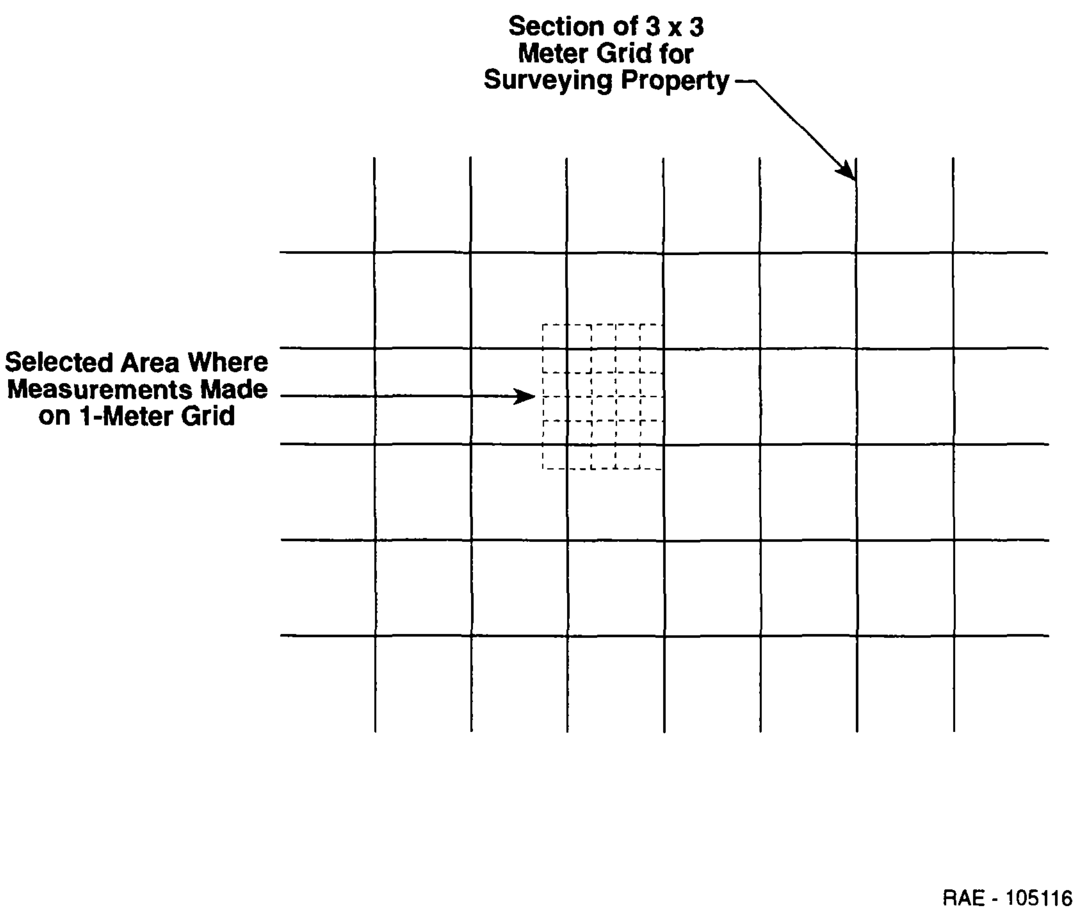

Figure 2-2. Example of radiation monitoring grids.

The basic measurements will be made in counts per minute or microroentgen per hour (uR/hr). The measurements will be reported in uR/hr and appropriate units of rad per hour.

2.2.1.3 Subsurface Borings

Subsurface borings will be made at five or more locations. Two borings will be drilled at the locations with the highest exposure rates. At least one boring will be drilled near a present parking attendant station to assess the present of subsurface contamination. One boring will also be placed outside of the area of evident elevated gamma exposure rates to identify natural background. Other borings may be placed to provide supplemental information on the volume of contaminated material and or assess contamination at other locations, based of information from the gamma survey and results from the initial soil borings.

The five borings shall be extended to the depth where natural and/or background soils are reached, if reasonable. If a boring cannot be drilled to a sufficient depth to reach natural soils or natural background concentrations of radioactivity, a second boring will be placed at a reasonable adjacent location. If debris or other subsurface obstacles or conditions prevent the completion of three borings within the same immediate area (e.g., radius of about 10 ft), the investigation of that immediate area may be abandoned. Logs of the physical characteristics of the borings will be made and gamma logs will be made for each boring where feasible (i.e., unless the hole cannot be kept open or it is abandoned due to instability, etc.). The borings will be constructed and gamma logged as denoted in the procedures in Appendix B.

One or more samples will be collected from each boring. Sampling will be performed using split-barrel or similar sampling procedures as outlined in Appendix B. The samples will be analyzed for gamma emitting radionuclides in the uranium and thorium decay chain (e.g., Ra-226, Pb-214, Pb-214, At-228, and Tl-208) and used to develop correlations for the boring gamma logs, as described in the Field Investigation Plan in Appendix B. PVC monitoring well casing will be used to case the holes during gamma logging.

Samples from the borings will also be analyzed for Resource Conservation and Recovery Act (RCRA) characteristics as denoted in the Field Investigation Report in Appendix B. The samples will be analyzed for the RCRA characteristics of corrosivity, ignitability, and toxicity. The analyses for the toxicity will be performed using Methods 1311, 8240, 8270, and 7000, including the analysis for volatile organic compounds (VOC), semi-volatile organic compounds, RCRA metals. The TCLP tests will not include the analyses for pesticides and herbicides, based on the history of the site.

The sampling and analyses are given in Table 2-1. The information indicates the samples that will be collected, the specified analytical methods, and the field and trip blank samples that shall be collected. The method number is not given for all of the radionuclide analyses since specific EPA method numbers are not used. The container requirements and other information are given in Appendix B.

2.2.1.4 Groundwater Samples

Four groundwater monitoring wells were installed during a site assessment in mid 1992. These wells have been surface closure devices. Review of the completion information (STS92) indicates they have been properly constructed and capped. The information on the construction of the wells is given in Appendix E.

The wells will be sampled using the procedures in Appendix B. Samples will be analyzed for metals, radium-226 and radium-228, and uranium using the sampling methods and analytical procedures identified in Appendix B. The samples will be filtered in the field.

Table 2-1. Field Investigation samples.

Type Sample	Location	Analyses to Be Performed								
		TCLP	Corrosvity	Ignitability	Reactivity	Th/U-Chm	U iso.	Gamma Sp U & Th+D	Rad Chem Ra226/28	SDWA Metals
Borings	1-Max Exp.									
	a	1	1	1	1	1	--	1	--	--
	b	--	--	--	--	--	--	1	--	--
	2-Max Exp.									
	a	1	1	1	1	1	--	1	--	--
	b	--	--	--	--	--	--	1	--	--
	3-Near Booth									
	a	1	--	--	--	1	--	1	--	--
	b	--	--	--	--	--	--	1	--	--
	4-Optional									
	a	1	--	--	--	1	--	1	--	--
	b	--	--	--	--	--	--	1	--	--
	5-Bkgd									
	a	1	1	1	1	1	--	1	--	--
	b	--	--	--	--	1	--	1	--	--
Groundwater										
	I	--	--	--	--	--	1	--	1	1
	II	--	--	--	--	--	1	--	1	1
	III	--	--	--	--	--	1	--	1	1
	IV	--	--	--	--	--	1	--	1	1
Blanks										
Boring Equip		2	--	--	--	--	--	1	--	--
Solid Blank		1	--	--	--	--	--	1	--	--
Solid QA Spike		--	--	--	--	1	--	1	1	--
Water Samp Equip		--	--	--	--	--	1	--	1	1
Water Blank		--	--	--	--	--	1	--	1	1
Trip Blanks		1	--	--	--	--	--	--	1	1
Totals		9	3	3	3	7	6	13	8	7
								Total Analyses		59

2.2.1.5 Sample Management

Samples will be collected using chain-of-custody procedures. The samples will be stored under chain-of-custody and cooled as specified by SW 846 (EPA86). The samples will be shipped to the RAE Laboratory in Salt Lake City, Utah, and Barringer Laboratories in Golden, Colorado, by Federal Express, or an alternate laboratory (accepted by EPA and Chicago Dock). The samples will be shipped daily or every other day to ensure compliance with sample holding times. Copies of the chain-of-custody sheets will be made available to the EPA.

RAE will analyze samples by gamma spectrum analysis as specified by the procedure in Appendix B. Barringer Laboratory will perform the RCRA characterization analyses and radiochemistry analyses using their standard procedures and the EPA methods denoted in Appendix B.

2.2.1.6 Closure of Borings

All borings will be filled by grouting or with bentonite, unless the holes collapse during withdrawal of equipment. The surface of boring locations will be covered with concrete patch about 0.1 square meter or larger.

2.2.1.7 Decontamination of Equipment and Collection of Monitoring Well Water

Equipment will be decontaminated onsite, in an area constructed to collect the water. The decontamination procedures are given in Appendix B. The sampling equipment will be decontaminated using a steam cleaner and non-phosphate detergent. Equipment will be double rinsed with deionized/distilled water. Acetone will be used prior to the rinse with deionized water, if required by the materials found on site.

The decontamination water and water from preparing the monitoring wells for sampling will be collected for off-site disposal. The water will be assayed for gross beta and gross alpha activity and screened for volatile organic compounds. It is anticipated that the water will be cleared for discharge to the municipal sewer.

2.2.2 Mobilization and Site Control

There will be limited mobilization for the Field Investigation. The surveying is scheduled to be performed the week before the radiation monitoring and sampling activities. The mobilization for sampling will include bringing a drill rig to the site and constructing a decontamination pad for containment of decontamination fluids. The mobilization activities will also include bringing a portable toilet to the site.

Arrangements will be made with the manager of the parking lot for scheduling the radiation survey and sampling activities. It is anticipated that about one-forth of the lot will be closed off for a given period of time to allow for radiation monitoring and sampling activities. Depending on the time period that people park and the possibility of moving parked cars, it may be necessary to close off up to one-half of the site at a time, to allow for proper monitoring and sampling.

2.2.3 Review Meetings and Status Reports

After preparation of the Work Plan, a review meeting will be held with EPA, Chicago Dock, and RAE. The agenda of the meeting will include resolving any uncertainties in the activities and schedule for the Field Investigation.

One week prior to the Field Investigation a conference call will be held with EPA, Chicago Dock, and RAE representatives. The agenda for the call will be resolving any questions concerning the activities and schedule for the Field Investigation.

A review meeting will be scheduled for about ten days after the completion of the Field Investigation. Preliminary information from the field activities will be presented.

3. HEALTH AND SAFETY

The Health and Safety Plan is included as Appendix C. The plan outlines the activities to be performed, provides an assessment of associated risks, and presents action criteria for control of risks.

The hazardous materials are presently confined by the asphalt pavement. The work areas, where subsurface exploration is performed, will be considered control areas with no eating, chewing, or smoking within a radius of forty feet of subsurface work. Special controls are given for work in areas where the external gamma exposure rate exceeds 400 uR/hr (i.e., 0.4 milliroentgen per hour).

4. QUALITY ASSURANCE/QUALITY CONTROL

The Quality Assurance Project Plan (QAPP) is given as Appendix D. The QAPP includes the 16 elements specified by EPA for a QAPP.

Rogers and Associates will use the RAE Quality Assurance Procedures. These procedures include maintaining written records of communications, maintaining a project file incorporating official records, communications, and reports, and documenting field investigation activities in bound log books.

This Work Plan will be the official document for performing the Field Investigation activities. The Field Investigation Manager will maintain the official copy of the Work Plan during the investigation activities. As specified in Section 2.1.1, any departures from the Work Plan will be written in the "Site Work Plan" and will be initialed by the EPA On-Scene Coordinator and the RAE Field Investigation Manager.

4.1 <u>FIELD ACTIVITIES</u>

The Field Investigation Activities will be performed in accordance with the QAPP and this Work Plan. These documents denote that properly calibrated instruments will be used for field activities, that defined procedures will be used, and that the activities and the proper implementation of these plans be documented.

4.2 <u>ANALYSIS OF SAMPLES</u>

Samples will be analyzed in accordance with the QAPP, the methods defined in the Field Investigation Plan in Appendix B, and the QA Plans of the appropriate laboratories.

Analytical data will be reviewed for compliance with applicable QA/QC criteria prior to release.

5. SCHEDULE AND PROJECT DELIVERABLES

This schedule is based on anticipated periods for review and obtaining appropriate approvals. The Work Plan is scheduled for delivery to EPA Region V on September 15. Based on expedited approval by EPA, the Field Investigation activities are Scheduled for the weeks of October 11 and 18, 1993. Survey activities will be performed the week of October 11 and the radiation monitoring and sampling activities will be performed the week of October 18. Assuming completion of the sampling activities by October 22, analytical results are scheduled to be available by November 10. A draft report will be issued on or before December 20, 1993.

It is proposed that status meetings by held the weeks of October 11 (finalize issues related to Field Investigation) October 25, November 15, and December 6, 1993. This schedule for status meetings is based on the development of information and the need to discuss and resolve issues. An agenda for the meetings, including the status of activities and results, will serve as "Status Reports." Conference telephone calls can be used in place of status meetings.

Figure 5-1 provides a summary of the schedule.

Figure 5-1. Schedule for work plan activities.

Activity	Completion of Activity	Meeting
Work Plan to EPA	September 15	
Meeting		October 11
Field Investigation		
Land Survey	October 11	
Rad Survey/Sampling	October 18	
Status Meeting		October 25
Laboratory Results	November 10	
Status Meeting		November 15
Status Meeting		December 6
Draft Report	December 20	

REFERENCES

STS92 STS Consultants Ltd., Report of Environmental Investigation. STS Project No. 27313-XH, September 29, 1992.

EPA86 U.S. Environmental Protection Agency, Test Methods for Evaluating Solid Waste. Office of Solid Waste and Emergency Response, PB88-239223, SW-846, Third Edition, September 1986.

WORK PLAN FOR CHARACTERIZATION OF RADIOACTIVE CONTAMINATION 316 EAST ILLINOIS STREET, CHICAGO, ILLINOIS

Appendix A

Administrative Order By Consent

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY REGION V

IN THE MATTER OF:	)	Docket No.
	)	
Lindsay Light II Site	)	ADMINISTRATIVE ORDER BY
Chicago, Illinois	)	CONSENT PURSUANT TO
	)	SECTION 106 OF THE
	)	COMPREHENSIVE
	)	ENVIRONMENTAL RESPONSE,
Respondent:	)	COMPENSATION AND
	)	LIABILITY ACT OF 1980,
The Chicago Dock & Canal Trust	)	as amended, 42 U.S.C.
	)	Section 9606(a)

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION V

IN THE MATTER OF:	)	Docket No.
	)	
Lindsay Light II Site Chicago, Illinois	)	ADMINISTRATIVE ORDER BY CONSENT PURSUANT TO SECTION 106 OF THE COMPREHENSIVE ENVIRONMENTAL RESPONSE, COMPENSATION AND LIABILITY ACT OF 1980, as amended, 42 U.S.C. Section 9606(a)
Respondent:	)	
The Chicago Dock & Canal Trust	)	

PREAMBLE

The United States Environmental Protection Agency (U.S. EPA) and the Respondent have each agreed to the making and entry of this Order by Consent.

It is issued pursuant to the authority vested in the President of the United States by Sections 106(a) and 122 of the Comprehensive Environmental Response, Compensation and Liability Act of 1980, 42 U.S.C. Section 9606(a), as amended by the Superfund Amendments and Reauthorization Act of 1986, Pub. L. 99-499 (CERCLA), and delegated to the Administrator of the U.S. EPA by Executive Order No. 12580, January 23, 1987, 52 Federal Register 2923, and further delegated to the Assistant Administrator for Solid Waste and Emergency Response and the Regional Administrators by U.S. EPA Delegation Nos. 14-14, 14-14-C and 14-14-D, and to the Director, Waste Management Division, Region V, by Regional Delegation Nos. 14-14-A, 14-14-C and 14-14-D.

A copy of this Order will also be provided to the State of Illinois, which has been notified of the issuance of this Order as required by Section 106(a) of CERCLA, 42 U.S.C. Section 9606(a).

This Order requires the Respondent to undertake and complete emergency removal activities to abate conditions which may present an imminent and substantial endangerment to the public health or welfare or the environment because of an actual or threatened release of hazardous substances at the Site.

FINDINGS

Based on available information, including the Administrative Record in this matter, U.S. EPA hereby finds:

1. The Lindsay Light II Site ("the Site" or "the Facility") is located at 316 East Illinois Street, Chicago, Cook County, Illinois. The Site is situated in a urban area called the Gold Coast, and is surrounded by commercial and residential buildings. A major shopping mall is located approximately 200 feet to the southeast. The Chicago River is located 1 mile south of the Site and Lake Michigan is about 1.5 miles east of the Site.

2. The Site is currently a parking lot operated by General Parking and owned by The Chicago Dock and Canal Trust. In August 1993, The Chicago Dock and Canal Trust plans to begin construction of a one-story retail complex on this Site.

3. Until 1936, Lindsay Light manufactured incandescent gas mantels at 161 East Grand, which is .25 miles from the Site. It is unknown if they worked elsewhere; however, Sanborn maps from 1906 do show Lindsay Light being at other Chicago locations. During 1931-1936, the company moved its operations to West Chicago, Illinois.

4. The principle ingredient in gas mantle manufacture is thorium as a nitrate. Small amounts of cerium, beryllium and magnesium nitrates are also used. Thorium occurs principally as the parent radionuclide thorium-232 in association with its daughter products in a decay sequence known as the Thorium Decay Series. Thorium radionuclides are also found in the Uranium Decay Series and the Actinium Decay Series. It is believed that the principal source of contamination at this Site is the Thorium Decay Series.

5. It is unclear what Lindsay Light actually did at 316 East Illinois; however, records from The Chicago Dock and Canal Trust indicate this Site was a stable.

6. On June 3, 1993, U.S. EPA and the Illinois Department of Nuclear Safety conducted a joint investigation at the Site. This investigation verified the presence of radioactivity at levels clearly above natural background and at levels that may pose an imminent and substantial endangerment to human health and the environment. Gamma readings were found as high as 280 uR/hr. Natural background is assumed to have gamma readings of 20 uR/hr.

DETERMINATIONS

Based on the foregoing Findings, U.S. EPA has determined that:

1. The Lindsay Light II Site is a "facility" as defined by Section 101(9) of CERCLA, 42 U.S.C. Section 9601(9).

2. The Chicago Dock & Canal Trust is a "person" as defined by Section 101(21) of CERCLA, 42 U.S.C. Section 9601(21).

4. Radionuclides are "hazardous substances" as defined by Section 101(14) of CERCLA, 42 U.S.C. Section 9601(14).

5. The detection of gamma rays as high as 280 uR/hr constitutes an actual or threatened "release" as that term is defined in Section 101(22) of CERCLA, 42 U.S.C. Section 9601(22).

6. The actual or threatened release of hazardous substances from the Facility may present an imminent and substantial endangerment to the public health, welfare, or the environment.

7. The actions required by this Order, if properly performed, are consistent with the National Contingency Plan (NCP), 40 CFR Part 300, as amended, and CERCLA; and are reasonable and necessary to protect the public health, welfare and the environment because of the following factors:

a. actual or potential exposure to nearby human populations, animals, or the food chain from hazardous substances, pollutants or contaminants;

This factor is present at the Facility due to the existence of a public parking lot on property found to have gamma readings as high as 280 uR/hr. Gamma rays are penetrating radiations indistinguishable from X-rays and when they interact with matter, such as the human body, the rays pass through the body. When matter thicker than the human body is put in the path of a gamma ray, the intensity of the gamma ray may be reduced, but not completely absorbed. Furthermore, there are two parking attendants stationed at this parking lot on a 24-hour basis to collect fees. The Site is also surrounded by commercial and residential buildings, whose occupants use this parking lot and adjacent sidewalks. Situated 200 feet southeast of the Site is the North Pier Shopping mall, which is a major Gold Coast attraction.

b. high levels of hazardous substances or pollutants or contaminants in soils largely at or near the surface, that may migrate;

This factor is present at the Facility due to the existence of elevated gamma levels as high as 280 uR/hr as compared to 10 uR/hr for natural background. These gamma levels are indicative of higher levels in the soils because the parking lot is covered with asphalt, which attenuates radiation.

c. other situations or factors which may pose threats to public health or welfare or the environment.

This factor is present at the Facility due to the property owner's intent to begin construction of a one-story retail complex in August, 1993 at this Site. This construction will entail excavating into potentially contaminated soils for placement of building footings, and may cause increased releases into the environment and human exposure to contaminants.

ORDER

Based upon the foregoing Findings and Determinations, and pursuant to Section 106(a) of CERCLA, 42 U.S.C. Section 9606(a), it is hereby ordered and agreed that Respondent will undertake the following actions at the Facility:

1. Within ten (10) business days after the effective date of this Order, the Respondent shall submit to U.S. EPA for approval, a Work Plan for the removal activities ordered as set forth in Paragraph 4 below. The Work Plan shall provide a concise description of the activities to be conducted to comply with the requirements of this Order. The Work Plan shall be reviewed by U.S. EPA, which may approve, disapprove, require revisions, or modify the Work Plan. Respondent shall implement the Work Plan as finally approved by U.S. EPA, including any modifications. Once approved, the Work Plan shall be deemed to be incorporated into and made a fully enforceable part of this Order.

2. The Work Plan shall contain a site safety and health plan, a sampling and analysis plan, and a schedule of the work to be performed. The site safety and health plan shall be prepared in accordance with the Occupational Safety and Health Administration (OSHA) regulations applicable to Hazardous Waste Operations and Emergency Response, 29 CFR Part 1910. The Work Plan and other submitted documents shall demonstrate that the Respondent can properly conduct the actions required by this Order.

3. Respondent shall retain a contractor qualified to undertake and complete the requirements of this Order, and shall notify U.S. EPA of the name of such contractor within five (5) business days of the effective date of this Order. U.S. EPA retains the right to disapprove of any, or all, of the contractors and/or subcontractors retained by the Respondent. In the event U.S. EPA disapproves of a selected contractor, Respondent shall retain a different contractor to perform the work, and such selection shall be made within two (2) business days following U.S. EPA's disapproval.

4. Within five (5) business days after U.S. EPA approval of the Work Plan, Respondent shall implement the Work Plan as approved or modified by U.S. EPA. Failure of the Respondent to properly implement all aspects of the Work Plan shall be deemed to be a violation of the terms of this Order. The Work Plan shall require the Respondent to perform, and complete within ninety (90) calendar days after approval, the following removal activities:

a. Develop and implement a Site Health and Safety Plan.

Licensed survey

b. Conduct land surveying to the extent necessary to locate all property boundaries and features, sample locations and areas having elevated radiation levels.

c. Place borings in several locations for the purpose of measuring subsurface radiation levels. Measurements shall be recorded until the natural soils are reached or radiation levels reach background, whichever is the greatest depth.

d. Collect soil samples from the borings and analyze for radionuclide content and RCRA characteristics. These results will then be used by the Respondent to correlate subsurface radiation levels and radionuclide content.

5. All materials removed from the Site shall be disposed of or treated at a facility approved by the On-Scene Coordinator and in accordance with the Resource Conservation and Recovery Act of 1976 (RCRA), 42 U.S.C. Section 6901, et seq., as amended, the U.S. EPA Revised Off-Site Policy, and all other applicable Federal, State, and local requirements.

6. On or before the effective date of this Order, the Respondent shall designate a Project Coordinator. The U.S. EPA has designated Verneta Simon, of the Emergency and Enforcement Response Branch, Response Section III, as its On-Scene Coordinator. The On-Scene Coordinator and the Project Coordinator shall be responsible for overseeing the implementation of this Order. To the maximum extent possible, communication between the Respondent and the U.S. EPA, and all documents, reports and approvals, and all other correspondence concerning the activities relevant to this Order, shall be directed through the On-Scene Coordinator and the Project Coordinator. During implementation of the Work Plan, the OSC and the Project Coordinator shall, whenever possible, operate by consensus, and shall attempt in good faith to resolve disputes informally through discussion of the issues.

7. The U.S. EPA and the Respondent shall each have the right to change their respective designated On-Scene Coordinator or Project Coordinator. U.S. EPA shall notify the Respondent, and

15. Respondent agrees to retain for six years following completion of the activities required by this Order copies of all records, files and data relating to hazardous substances found on the Site, or related to the activities undertaken pursuant to this Order, whether or not those documents were created pursuant to this Order. Respondent shall acquire and retain copies of all documents relating to the Site that are in the possession of its contractors, agents and employees. Respondent shall notify U.S. EPA at least sixty (60) calendar days before any documents retained under this paragraph are to be destroyed. The documents retained under this paragraph shall be made available to the U.S. EPA upon request.

16. Respondent shall pay all past costs and oversight costs of the United States related to the Lindsay Light II Site which are not inconsistent with the National Contingency Plan. The United States shall submit an itemized cost statement entitled "Itemized Cost Summary" to Respondent annually or, if sooner, not less than 60 calendar days after submission of the Final Report provided for in Paragraph 24 of this Order. Payments shall be made within 60 calendar days of Respondent's receipt of the cost statement. Payments shall be made to the EPA Hazardous Substances Superfund delivered to the U.S. EPA, Attn: Superfund Accounting, P.O. Box 70753, Chicago, Illinois 60673, in the form of a certified or cashier's check payable to "EPA Hazardous Substances Superfund." The face of the check should note that the payment is for the Lindsay Light II Site, Superfund Site Identification Number YT. Respondents are jointly and severally liable for payment of the full amount due under this Order. A copy of the check(s) submitted must be sent simultaneously to the U.S. EPA representatives indicated in Paragraph 17 below.

17. A notice, document, information, report, plan, approval, disapproval or other correspondence required to be submitted from one party to another under the Order shall be deemed submitted either when hand delivered or as of the date of receipt by certified mail, return receipt requested.

Submissions to the Respondent shall be submitted to:

The Chicago Dock & Canal Trust
455 East Illinois Street
Suite 565
Chicago, Illinois 60611

Submissions to the U.S. EPA shall be submitted to:

Verneta Simon
On-Scene Coordinator
U.S. Environmental Protection Agency
77 West Jackson Boulevard, HSE-5J
Chicago, Illinois 60604

18. If any provision of this Order is deemed invalid or unenforceable, the remainder of this Order shall remain in full force and effect.

STIPULATED PENALTIES

19. For each day the Respondent fails to meet the deadlines set forth in the Consent Order and Work Plan, Respondent shall be liable as follows:

	Penalty For: First Week or Part Thereof	Each Following Week or Part Thereof
Failure to Submit the Work Plan, Site Safety and Health Plan, Sampling and Analysis Plan or the Schedule of Work to be Performed	\$2,000	\$3,500
Failure to Commence Implementation of the Work Plan	\$2,000	\$3,500
Failure to Meet any Scheduled Deadline in the Work Plan	\$2,000	\$3,500
Failure to Submit Monthly Reports	\$ 800	\$ 500

20. All penalties which accrue pursuant to the requirements of this Order shall be paid within fifteen (15) business days of written demand by U.S. EPA. Payment shall be made to the EPA Hazardous Substances Superfund delivered to the U.S. EPA, Attn: Superfund Accounting, P.O. Box 70753, Chicago, Illinois 60673, in the form of a certified or cashier's check payable to "EPA Hazardous Substances Superfund." The face of the check should note that the payment is for the Lindsay Light II Site.

21. Pursuant to 31 U.S.C. Section 3717, interest shall accrue on any amount of overdue stipulated penalties at a rate established by the United States Treasury. Stipulated penalties shall accrue, but need not be paid, during any dispute resolution period concerning the particular penalties at issue. If Respondent prevails upon resolution, Respondent shall pay only such penalties as the resolution requires.

22. Payment of Stipulated Penalties will not relieve Respondent from complying with the terms of this Consent Order. U.S. EPA retains the right to seek any remedies or sanctions available to U.S. EPA by reason of Respondent's noncompliance with the provisions of this Consent Order that are not otherwise expressly limited by these Stipulated Penalty provisions.

PENALTIES FOR NONCOMPLIANCE

23. Respondent is advised pursuant to Section 106(b) of CERCLA, 42 U.S.C. Section 9606(b), that violation or subsequent failure or refusal to comply with this Order and any Work Plan approved under this Order, or any portion thereof, may subject the Respondent to a civil penalty of no more than $25,000 per day for each day in which such violation occurs, or such failure to comply continues. In addition, failure to properly provide removal action upon the terms of this order, or other subsequent orders issued by U.S. EPA, may result in liability for punitive damages pursuant to Section 107(c)(3) of CERCLA, 42 U.S.C Section 9607(c)(3).

TERMINATION AND SATISFACTION

24. The Respondent shall submit a final report summarizing the actions taken to comply with this Order. The report shall contain, at a minimum: identification of the facility, a description of the locations and types of hazardous substances encountered at the facility upon the initiation of work performed under this Order, a chronology and description of the actions performed (including both the organization and implementation of response activities), a listing of the resources committed to perform the work under this Order (including financial, personnel, mechanical and technological resources), identification of all items that affected the actions performed under the Order and discussion of how all problems were resolved, a listing of quantities and types of materials removed, a discussion of removal and disposal options considered for those materials, a listing of the ultimate destination of those materials, and a presentation of the analytical results of all sampling and analyses performed and accompanying appendices containing all relevant paperwork accrued during the action (e.g., manifests, invoices, bills, contracts, permits). The final report shall also include an affidavit from a person who supervised or directed the preparation of that report. The affidavit shall certify under penalty of law that based on personal knowledge and appropriate inquiries of all other persons involved in preparation of the report, the information submitted is true, accurate and complete to the best of the affiant's

knowledge and belief. The report shall be submitted within sixty (60) calendar days of completion of the work required by the U.S. EPA.

25. The provisions of this Order shall be deemed satisfied upon payment by Respondent of all sums due under the terms of this Order and upon the Respondent's receipt of written notice from U.S. EPA that the Respondent has demonstrated, to the satisfaction of U.S. EPA, that all of the terms of this Order, including any additional tasks consistent with this Consent Order which U.S. EPA has determined to be necessary, have been completed.

INDEMNIFICATION

26. The Respondent agrees to indemnify and save and hold harmless the United States Government, its agencies, departments, agents, and employees, from any and all claims or causes of action arising from, or on account of, acts or omissions of the Respondent, its officers, employees, receivers, trustees, agents, successors or assigns, in carrying out the activities pursuant to this Order. The United States Government shall not be held as a party to any contract entered into by the Respondent in carrying out activities under this Order.

RESERVATION OF RIGHTS

27. This Order is not intended for the benefit of any third party and may not be enforced by any third party.

28. The U.S. EPA and the Respondent reserve all rights, claims, demands, and defenses, including defenses and denials of and to all determinations and findings, that they may have as to each other except as otherwise provided in this Order pursuant to any available legal authority. Nothing in this Order shall expand the Respondent's ability to obtain preenforcement review of U.S. EPA actions. Notwithstanding any reservation of rights, Respondent agrees to comply with the terms and conditions of this Order and consents to the jurisdiction of the U.S. EPA to enter into and enforce this Order.

29. Nothing herein is intended to release, discharge, limit or in any way affect any claim, causes of action or demands in law or equity which the parties may have against any persons, firm, trust, joint venture, partnership, corporation, or other entity not a party to this Order for any liability it may have arising out of, or relating in any way to, the generation, storage, treatment, handling, transportation, disposal, release or threat of release of any hazardous substance, hazardous waste, contaminant or pollutant at or from the Site. The parties to

this Order hereby expressly reserve all rights, claims, demands and causes of action they may have against any and all other persons and entities who are not parties to this Order.

30. Nothing herein shall be construed: 1) to prevent U.S. EPA from exercising its right to disapprove of work performed by the Respondent; 2) to prevent U.S. EPA from seeking legal or equitable relief to enforce the terms of this order; 3) to prevent U.S. EPA from taking other legal or equitable action not inconsistent with the Covenant Not To Sue in Paragraphs 41 through 43 of this Order; 4) to prevent U.S. EPA from requiring the Respondent in the future to perform additional activities pursuant to CERCLA, 42 U.S.C. Section 9601 et seq., or any other applicable law; or 5) to prevent U.S. EPA from undertaking response actions at the Site.

FORCE MAJEURE

31. The Respondent shall cause all work to be performed within the time limits set forth herein and in the approved Work Plan, unless performance is delayed by "force majeure". For purposes of this Order, "force majeure" shall mean an event arising from causes entirely beyond the control of the Respondent and it's contractors which delays or prevents the performance of any obligation required by this Order. Increases in costs, financial difficulty, normal inclement weather, and delays encountered by the Respondent in securing any required permits or approvals are examples of events that are not considered to be beyond the control of the Respondent.

32. Respondent shall notify the OSC within 24 hours after Respondent becomes aware of any event which Respondent contends constitutes a force majeure, with subsequent written notice within seven (7) calendar days of the event. Such written notice shall describe: 1) the nature of the delay, 2) the cause of the delay, 3) the expected duration of the delay, including any demobilization and remobilization resulting from the delay, 4) the actions which will be taken to prevent or mitigate further delay, and 5) the timetable by which the actions to mitigate the delay will be taken. Respondent shall implement all reasonable measures to avoid and/or minimize such delays. Failure to comply with the notice provision of this paragraph shall be grounds for U.S. EPA to deny Respondent an extension of time for performance. The Respondent shall have the burden of demonstrating by a preponderance of the evidence that the event is a force majeure, that the delay is warranted under the circumstances, and that best efforts were exercised to avoid and mitigate the effects of the delay. If U.S. EPA determines a delay is or was attributable to a force majeure, the time period for performance under this Order shall be extended as deemed necessary by the OSC to allow performance.

DISPUTE RESOLUTION

33. The Parties to this Order on Consent shall attempt to resolve expeditiously and informally any disagreements concerning implementation of this Order on Consent or any work required hereunder.

34. In the event that any dispute arising under this Order on Consent is not resolved expeditiously through informal means, any party desiring dispute resolution under this Section shall give prompt written notice to the other parties to the Order.

35. Within ten (10) calendar days of the service of notice of dispute pursuant to Paragraph 34 above, the party who gave notice shall serve on the other parties to this Order a written statement of the issues in dispute, the relevant facts upon which the dispute is based, and factual data, analysis or opinion supporting its position, and all supporting documentation on which such party relies (hereinafter the "Statement of Position"). The opposing parties shall serve their Statement of Position, including supporting documentation, no later than ten (10) calendar days after receipt of the complaining party's Statement of Position. In the event that these 10-day time periods for exchange of Statements of Position may cause a delay in the work, they shall be shortened upon and in accordance with notice by U.S. EPA.

36. An administrative record of any dispute under this Section shall be maintained by U.S. EPA. The record shall include the written notification of such dispute, and the Statements of Position served pursuant to the preceding paragraphs.

37. Upon review of the administrative record, the Director of the Waste Management Division, U.S. EPA, Region V, shall resolve the dispute consistent with the NCP and the terms of this Order.

NON-ADMISSION

38. The consent of the Respondent to the terms of this Order shall not constitute or be construed as an admission of liability or of U.S. EPA's findings or determinations contained in this Order in any proceeding other than a proceeding to enforce the terms of this Order.

CERCLA FUNDING

39. The Respondent waives any claims or demands for compensation or payment under Sections 106(b), 111 and 112 of CERCLA against the United States or the Hazardous Substance Superfund established by 26 U.S.C. §9507 for, or arising out of,

any activity performed or expenses incurred pursuant to this Consent Order.

40. This Consent Order does not constitute any decision on preauthorization of funds under Section 111(a)(2) of CERCLA.

COVENANT NOT TO SUE

41. Upon termination and satisfaction of this Administrative Order pursuant to its terms, for and in consideration of the complete and timely performance by Respondent of the obligations agreed to in this Order, U.S. EPA hereby covenants not to sue Respondent for judicial imposition of damages or civil penalties for any failure to perform obligations agreed to in this Order except as otherwise reserved herein.

42. Performance of the terms of this Order resolves and satisfies the liability of the Respondent to U.S. EPA for work satisfactorily performed under this Order. U.S. EPA recognizes that, pursuant to Section 113 of CERCLA, the Respondent, upon having resolved it's liability with the U.S. EPA for the matters expressly covered by this Order, shall not be liable for claims for contribution regarding matters addressed in this Order. Nothing in this Order precludes the Respondent from asserting any claims, causes of action or demands against potentially responsible parties (PRPs) who are not parties to this Order for indemnification, contribution, or cost recovery.

43. In consideration of the actions to be performed by the Respondent under this Order, the U.S. EPA covenants not to sue the Respondent, its successors or assigns for any and all claims which are available to the U.S. as against the Respondent under Sections 106 and 107 of CERCLA concerning all matters satisfactorily performed.

SUBSEQUENT AMENDMENT

44. This Consent Order may be amended by mutual agreement of U.S. EPA and the Respondent. Any amendment of this Consent Order shall be in writing, signed by U.S. EPA and the Respondent and shall have as the effective date, that date on which such amendment is signed by U.S. EPA.

LINDSAY LIGHT II SITE
CHICAGO, ILLINOIS

SIGNATORIES

Each undersigned representative of a signatory to this Administrative Order on Consent certifies that he or she is fully authorized to enter into the terms and conditions of this Order and to bind such signatory, its directors, officers, employees, agents, successors and assigns, to this document.

Agreed this ___________ day of ______________, 1993.

By ____
The Chicago Dock & Canal Trust

The above being agreed and consented to, it is so ORDERED

this _______________ day of _________________, 1993.

By ____________________________________
William E. Muno, Director
Waste Management Division
U.S. Environmental Protection Agency
Region V, Complainant

RAE-9351/2-1
Appendix B

WORK PLAN FOR CHARACTERIZATION OF RADIOACTIVE CONTAMINATION 316 EAST ILLINOIS STREET, CHICAGO, ILLINOIS

Appendix B

Field Investigation Plan

316 EAST ILLINOIS PROJECT
CHICAGO, ILLINOIS

Rogers & Associates Engineering Corporation
P.O. Box 330, Salt Lake City, Utah 84110-0330

September 1993

1. INTRODUCTION

The U.S. Environmental Protection Agency Region V (EPA) and Illinois Department of Nuclear Safety (IDNS) measured elevated gamma radiation levels on portions of the 316 East Illinois Street property in Chicago, Illinois. Property records indicate that Lindsay Light Company leased the site from about 1915 to 1932. Lindsay Light Company made lantern mantels containing thorium, but no specific process activities have been documented for this site. The 316 East Illinois Street site is herein referred to as "the property" or the 316 East Illinois site.

1.1 OBJECTIVE

This plan describes procedures to be used to characterize the radioactive materials present at the 316 East Illinois Street site. The characterization includes determining the radioactive materials that are present, the concentrations of the radioactive materials, and the Resource Conservation and Recovery Act (RCRA) characteristics as defined in 40 CFR 261. Groundwater samples will be obtained from four shallow monitoring wells installed on the site during an environmental investigation in 1992.

The Field Investigation Plan, Health and Safety Plan, and Quality Assurance Project Plan are incorporated in the Work Plan.

1.2 REPORT CONTENT

This Field Investigation Plan defines the tasks for determining the presence of radioactive contamination and characterizing the apparent radioactive contamination at the property. The plan includes a summary of information from prior investigations performed at the property and provides the plans for performing the field activities and sample analysis procedures for characterizing the site. This Field Investigation Plan is an appendix in the Project Work Plan. The Health and Safety and Quality Assurance Project Plans (QAPP) are Appendices C and D, respectively, in the Work Plan.

Chapter 1 provides a description of the property. Chapter 2 provides the scope of work and the project management. Chapter 3 describes the environmental monitoring and sampling work to be performed. Appendices provide specific procedures for performing the work tasks and describe the procedures for decontamination of sampling equipment. The schedule and project deliverables are given in Chapter 5 of the Work Plan. Appendix E of the Work Plan provides additional historic information on the 316 East Illinois site and the sampling results from the 1992 environmental assessment by STS (STS92).

1.3 PROJECT DESCRIPTION AND BACKGROUND

The Chicago Dock and Canal Trust (Chicago Dock) property, at 316 East Illinois, extends between East Illinois Street on the south to Grand Avenue on the north. It is bounded by Columbus Drive on the west and McClurg Court on the east. Figure 1 shows the general layout of the site. Figure 2 is a location map, indicating the location of the property within the state of Illinois and the City of Chicago.

The U.S. Environmental Protection Agency (EPA) measured elevated gamma radiation levels on portions of the site and has designated the site as Lindsay Light II. The property, which was leased to Lindsay Light prior to about 1933, is presently undeveloped and has been used as a parking lot in recent years. The lot, operated by General Parking Company, is paved with asphalt and has guard rails to border the parking lot.

Chicago Dock and Canal Company was founded in 1857. Chicago Dock and Canal Trust, the direct successor of Chicago Dock and Canal Company, is a real estate investment trust formed in 1962. Both companies are included in the reference to "Chicago Dock," Chicago Dock records indicate that the property was leased to Lindsay Light from about 1915 to 1932. Information from historic record searches, indicates that prior to 1915, there were several industrial and manufacturing operations on the site. These activities, dating back

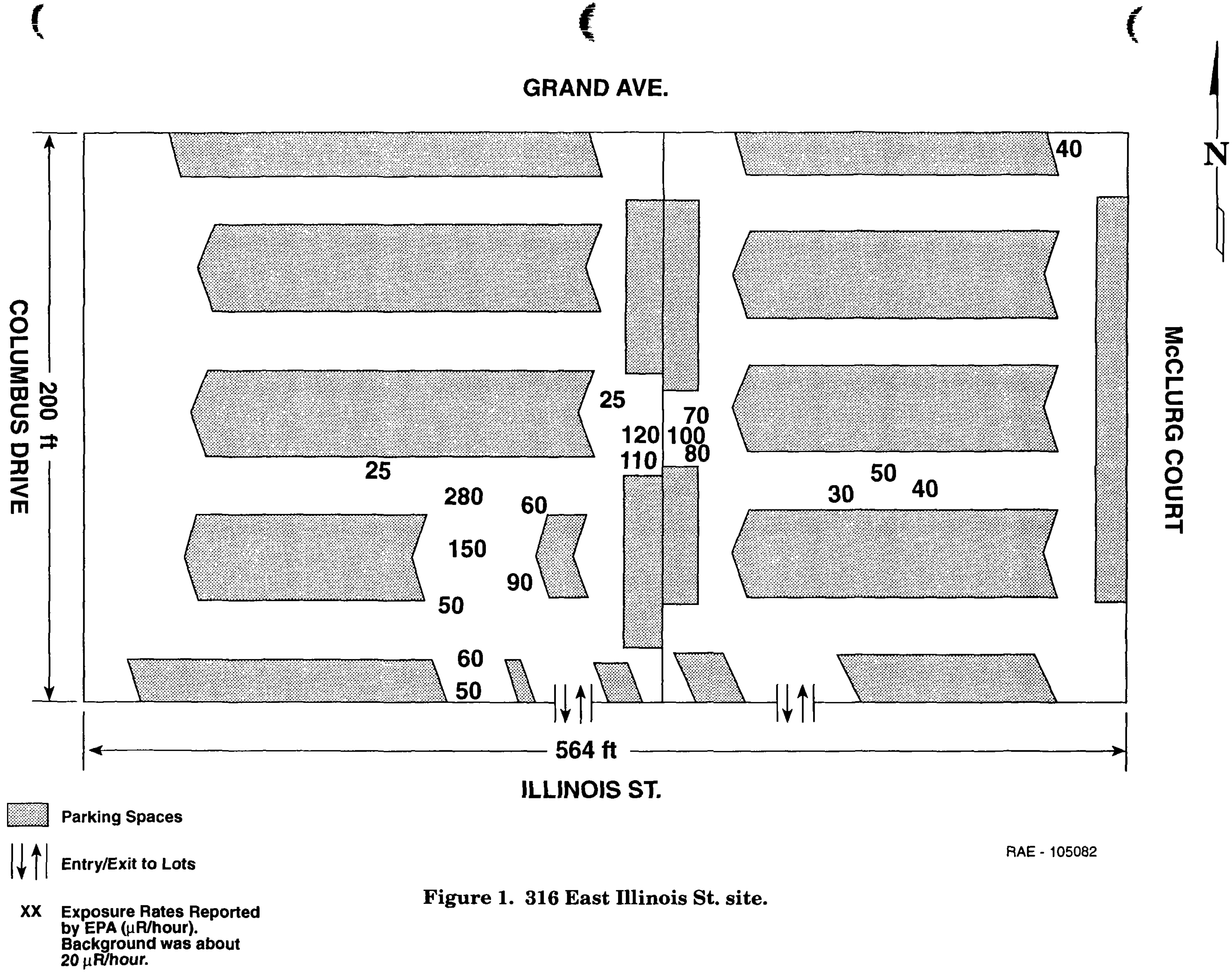

Figure 1. 316 East Illinois St. site.

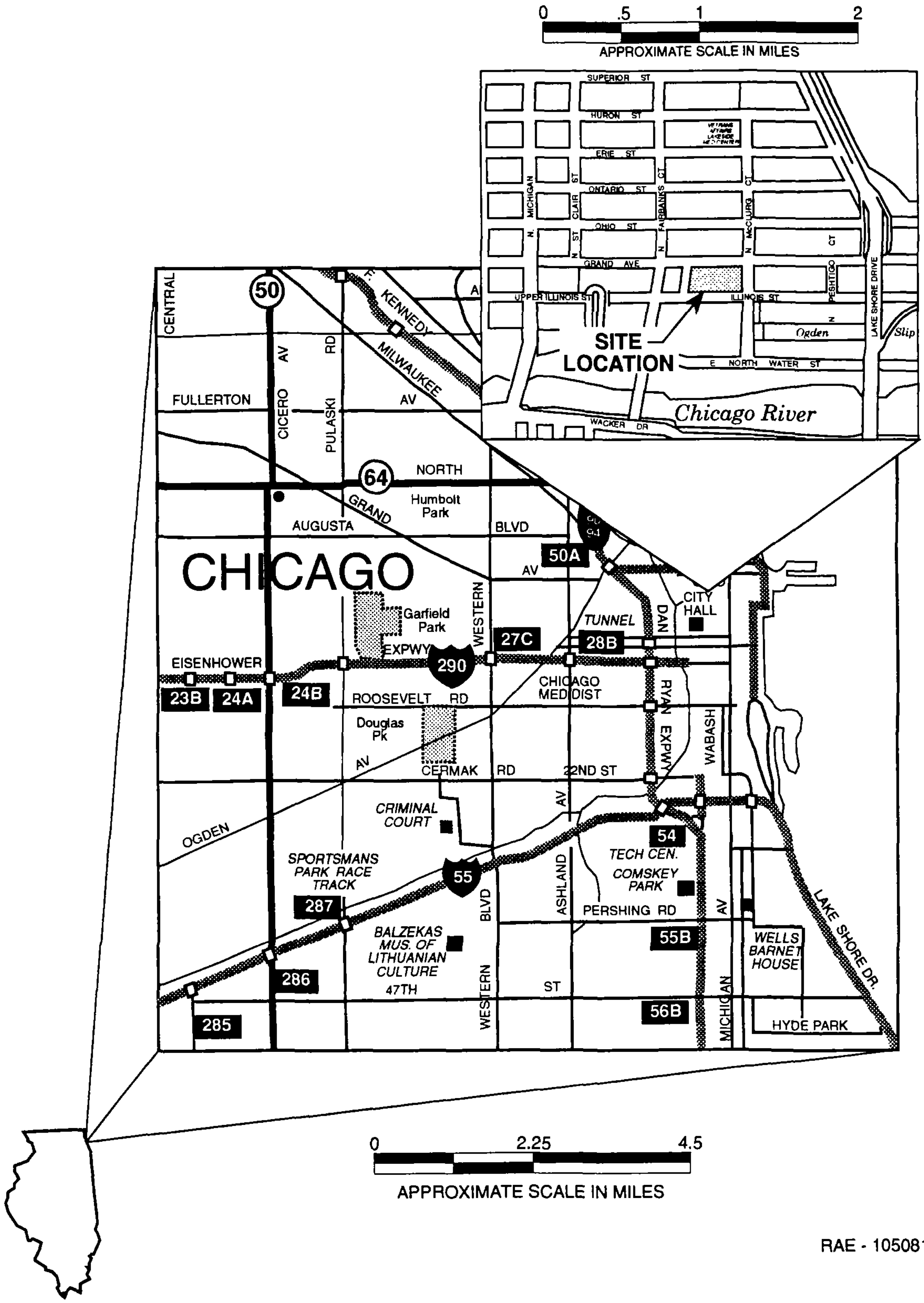

Figure 2. 316 East Illinois location map.

to about 1900, apparently included a metal polishing plant, a carbonic acid manufacturer, and a lubricating oil plant with underground storage tanks (STS92). Records also indicate that the property from 216 to 322 East Illinois was rented by Cooper's Stable prior to 1913 till 1914 or later. A two-story building on the property housed a stable for horses and wagons and a blacksmith shop.

In 1914 the Cooper Stable was divided in half, from east to west. The south half, fronting on Illinois at 316-322 was leased by Lindsay Light. Chicago Dock's records indicate that Lindsay Light made rent and tax payments on this property until about 1932. The building was demolished around 1933, which is consistent with the cessation of rent payments by Lindsay Light.

Review of property records indicates that Lindsay Light probably performed its primary manufacturing operations in this area of Chicago at 161 East Grand Ave, about one-quarter mile west of the property. The perception is that the manufacturing operations were performed at 161 East Grand Ave, and that the 316 East Illinois site was used as a warehouse site and as a stable to provide support services for transporting material to and from the main site.

1.2.1 Prior Investigations

There are records of two site investigations at the 316 East Illinois property. In mid 1992 STS Consultants Ltd. performed an environmental investigation for POWER/CRSS related to the proposed purchase of property for the Proposed Northwestern Memorial Hospital Facility Redevelopment Site. In mid 1993 the EPA and IDNS performed a radiation survey on the site, based on information from the review of historic land ownership records which indicated that Lindsay Light had operations at the site.

1.2.1.1 STS Site Investigation

STS Consultants Ltd. (STS92) performed a site investigation at the property in mid 1992. The investigation included the property between East Illinois Street Grand Avenue, and Columbus Drive and McClurg Court. These are also the property boundaries for the 316 East Illinois site (see Figure 1).

The STS site investigation included digging several investigation test pits, installing four shallow groundwater monitoring wells, and drilling numerous borings to obtain soil samples. STS reported that petroleum is spread over an area of approximately 24,000 square feet of the site. Petroleum residuals were present at a depth of about 13 ft, and extended about 4 ft below and above the water table. There was no measurable thickness of petroleum residue floating on the water table in the monitoring wells. A figure indicating the sampling locations and tables providing a summary of the results are given in Appendix E of the Work Plan.

The following items summarize the results of the STS investigation:

- No radioactive monitoring was performed and no samples were specifically analyzed for the presence of radioactive materials.

- Petroleum hydrocarbons (TPH) and polynuclear aromatic hydrocarbons (PNA) were present in many samples. The detection of volatile organic compounds ((VOC) xylene and/or ethylbenzene) indicates the presence of petroleum or petroleum products; probably diesel, heating, or heavy lubricating oil. Benzene and toluene were not detected in the soil or water samples. The measured concentrations of total xylenes and ethylbenzene, the other constituents of BTEX, were less than 1 ppm (parts per million or mg per kg).

- Trace levels of several chlorinated solvents compounds (e.g., tetrachloroethene, trichloroethene, and tetrachloromethane) were detected in three test pit samples. However, the concentrations were at the trace level, and were not present in boring or groundwater samples. The identified concentrations were less than 1 ppm.

- No detectable levels of PCBs were observed in the soil samples. Barium was the only RCRA heavy metal with an elevated concentration in the soil samples. The concentration in boring B-128 was 12 ppm of barium. The other concentrations, in samples where metals were analyzed, were about 1.1 ppm of barium or less.

- Total lead and chromium concentrations in water exceeded the EPA MCLs in three of the monitoring well samples. The concentrations of total lead were 0.5, 1.8, and 2.9 ppm in samples from wells MW-128, MW-130, and MW-131, respectively.

- The concentrations of TPH and PNAs ranged up to over 15,000 ppm.

1.2.1.2 Radiation Investigations by EPA and IDNS

EPA and IDNS performed radiation surveys at several former Lindsay Light sites in the area of Chicago near the subject property in mid 1993. On June 1, 1993, they performed a radiation survey at the 316 East Illinois site and discovered the presence of elevated gamma exposure rates. The information from this survey is given on Figure 1.

The records for the past use of the property indicate that the elevated radiation measurements may be due to residuals of material from Lindsay operations.

2. SCOPE OF WORK

On July 15, 1993, EPA issued a draft Administrative Order of Consent (AOC) to Chicago Dock (Appendix A of Work Plan). The AOC requested Chicago Dock to prepare a Work Plan for site investigations. This Field Investigation Plan describes the field tasks for characterizing the 316 East Illinois property. The field tasks include performing radiation surveys, obtaining subsurface samples, collecting groundwater samples and analysis of the samples.

2.1 PROJECT MANAGEMENT

The project management organization is given in Figure 3. The work will be performed under EPA oversight. Ms. Verneta Simon, of the EPA Region 5 Office, Emergency and Enforcement Response Branch, Response Section III, will be the EPA On-Scene Coordinator. Dr. Vern C. Rogers, of Rogers and Associates Engineering (RAE) is the Project Manager, and the Project Coordinator. Mr. David Bernhardt is the Assistant Project Manager and the Field Investigation Manager.

Dr. Rogers, as the Project Manager, is responsible for ensuring full implementation of the Work Plan. Mr. Bernhardt, the Field Investigation Manager, will be responsible for implementation of this Field Investigation Plan. Section 2.1 of the Work Plan identifies the responsibility of other key individuals identified in Figure 3.

2.2 HEALTH AND SAFETY

The Health and Safety Plan is included as Appendix C of the Work Plan. The plan outlines the activities to be performed, provides an assessment of associated risks, and presents action criteria for control of risks.

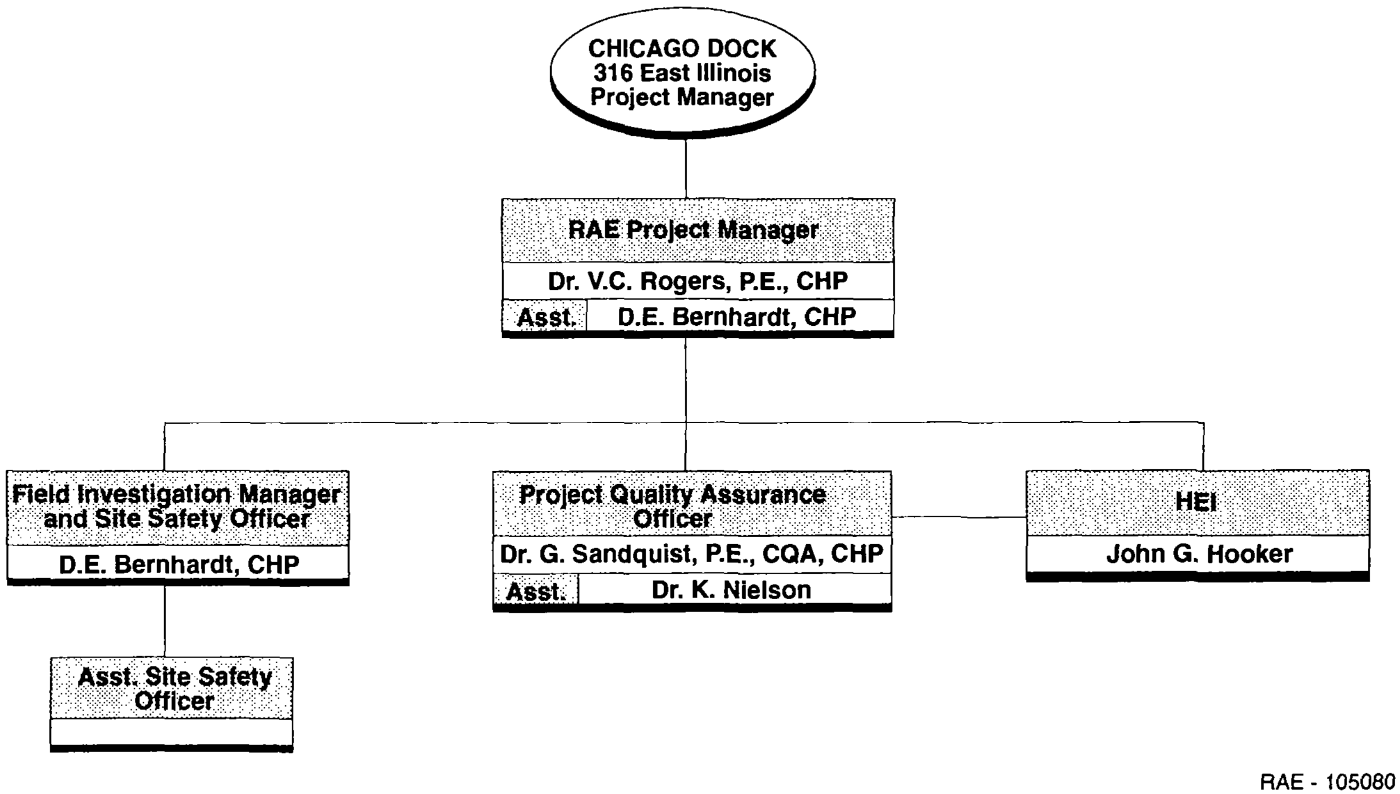

Figure 3. 316 East Illinois Project organization chart.

The hazardous materials are presently confined by the asphalt pavement. The work areas, where subsurface exploration is performed, will be considered control areas with no eating, chewing, or smoking within a radius of forty feet of subsurface work. Special controls are given for work in areas where the external gamma exposure rate exceeds 400 μR/hr (i.e., 0.4 milliroentgen per hour).

2.3 QUALITY ASSURANCE/QUALITY CONTROL

The Quality Assurance Project Plan (QAPP) is given as Appendix D of the Work Plan. The QAPP includes the 16 elements specified by EPA for a QAPP.

Rogers and Associates will use the RAE Quality Assurance Procedures. These procedures include maintaining written records of communications, maintaining a project file incorporating official records, communications, and reports, and documenting field investigation activities in bound log books. The Work Plan will be the official document for performing the Field Investigation activities. The Field Investigation Manager will maintain the official copy of the Work Plan during the investigation activities.

3. FIELD INVESTIGATION ACTIVITIES

The Field Investigation will include land surveying, radiation monitoring, drilling borings, gamma logging borings, subsurface sampling from borings, collecting groundwater samples, and analysis of samples. The these activities or tasks will include:

a. Perform a land survey to provide a definitive basis for locating radiation survey and sampling locations. The survey will provide both horizontal coordinates and elevation bench marks.

b. Perform an external gamma radiation survey on 3-meter grid lines over the site. The radiation survey will be performed with 1-inch NaI detectors. Supplemental measurements will be made to cross reference the NaI measurements to either a tissue equivalent dose-rate instrument (e.g., HP 1010) or other instrument measuring true exposure rate in microroentgen per hour or effective dose equivalent.

c. Drill approximately 5 boreholes for collecting samples of subsurface solids. The borings will be placed in the suspected areas of contamination and at a minimum of one background location to determine subsurface radiation levels and obtain samples of the subsurface materials. Gamma logs will be taken in the boreholes using a NaI gamma radiation detector.

d. Collect samples from the borings and analyze the samples for radionuclides in the uranium and thorium decay chains and RCRA characteristics. Splits of these samples will be made available to EPA. Samples will be collected and managed under chain-of-custody procedures.

e. Collect water samples from the four shallow groundwater monitoring wells previously installed by STS Consultants Ltd., as part of their investigation in 1992. The water samples will by analyzed for uranium, radium-226 and -228, and the metals listed in 40 CFR 141.11 of the EPA Primary Drinking Water Regulations.

3.1 SITE SURVEY

A land survey will be performed by surveyors licensed in the State of Illinois prior to the initiation of site sampling. The survey will provide both horizontal coordinates and elevations. Fixed survey pins will be placed at the four corners of the property and near the center of the property, and coordinates for the existing monitoring wells will be determined. The survey will provide sufficient detail for providing an accurate 3-m by 3-m grid for performing the gamma survey. Sufficient bench marks will also be established for determining future sampling locations. The survey will be tied into the U.S Geological Survey grid or other appropriate Chicago/Illinois grid system. If necessary the site will be re-surveyed after sampling to provide the coordinates for sampling locations.

3.2 RADIATION SURVEY OF SITE

An external gamma radiation survey will be performed of the property. The survey will be extended into the surrounding right-of-ways if there are indications of elevated gamma exposure rates in these areas. The survey shall not be extended onto private property not owned by Chicago Dock. At least one-fourth of the site will be surveyed prior to initiation of subsurface sampling. Assuming the area is accessible, the central area of the site, where EPA indicated the highest radiation readings were (see Figure 1), will be surveyed to allow selection of an initial subsurface sampling location to expedite performing all tasks of the Field Investigation Plan. Furthermore, applicable areas of the site will be surveyed before location of the decontamination pad and any other staging areas, to ensure proper selection of subsurface sample locations.

A survey grid, based on 3-meter intersects will be used for the survey. Measurements will be made at each grid intersect point, and general monitoring will be performed between points to ensure areas of maximum exposure are not overlooked. The survey will be performed using 1-inch NaI detectors, at a height of 1-meter above the surface. The observation of readings between grid points will ensure the identification of locations with the highest exposure rates. More detailed surveys (e.g., at a minimum of 1-meter spacings) will be made for the three general areas with the highest exposure rates and/or in areas where the exposure rate is greater than 200 µR/hr. Detailed surveys will be performed in the three areas with the highest gamma exposure rates to ensure the locations of the highest exposure rates are identified. All of the property area in Figure 1 will be surveyed. Figure 4 provides an example of where fixed measurements shall be made and the survey of an area where one of the maximum exposure rate measurements is identified. Measurements at grid points will be made using an instrument with a scaler, versus a rate meter, subject to the availability of instruments. These measurements will be made with Ludlum Model 2220 Model 3 (modified with rate meter) or equivalent instruments.

Surface measurements (detector at surface level) will be made at 10 or more of the grid points where the highest gamma exposure rates were measured.

Measurements will be made at 10 or more of the gamma measurement grid points with a tissue equivalent instrument (e.g., Health Physics Model 1010) to provide a correlation for estimating the air-kerma (i.e., dose in rad) and other dosimetry units (e.g., effective dose equivalent (EDE)).

The basic gamma survey measurements will be made in counts per minute or microroentgen per hour (µR/hr). The measurements will be reported in µR/hr and appropriate units of rad per hour.

3.3 SUBSURFACE BORINGS

Subsurface borings will be drilled at five or more locations. Two borings will be drilled at the locations with the highest exposure rates. At least one boring will be drilled near a present parking attendant station to assess the present of subsurface contamination. One boring will also be placed outside of the area of elevated gamma exposure rates to determine natural background values. Other borings may be placed to provide supplemental information on the volume of contaminated material or assess contamination at other locations, based on information from the gamma survey and results from the initial soil borings.

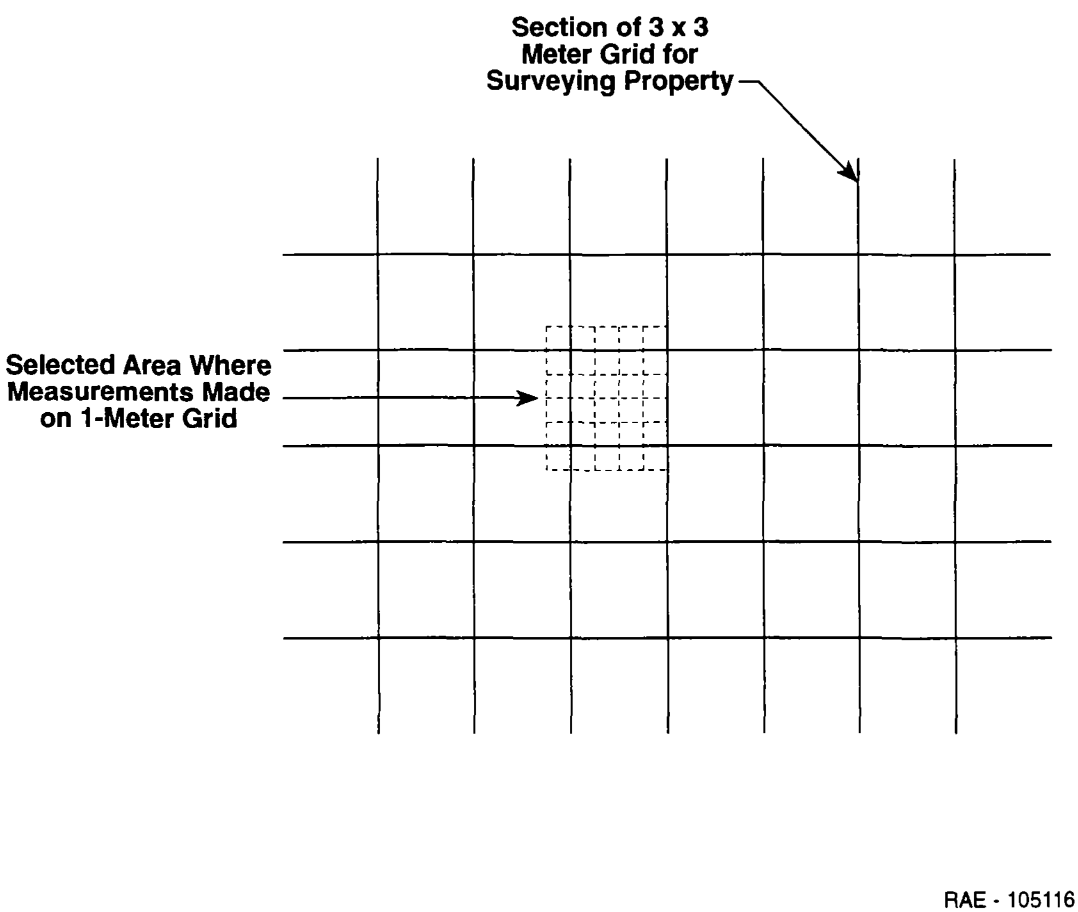

Figure 4. Example of radiation monitoring grids.

The five borings shall be extended to the depth where natural and/or background soils are reached, if reasonable. If a boring cannot be drilled to a sufficient depth to reach natural soils or natural background concentrations of radioactivity, a second boring will be drilled at a reasonable adjacent location. If debris or other subsurface obstacles or conditions prevent the completion of three borings within the same immediate area (e.g., radius of about 10 ft), the investigation of that immediate area may be abandoned.

It is anticipated that two of the boring locations will be located in the two areas identified by EPA in Figure 1 as having the highest gamma readings. These general areas are the central southern section of the site and the central area in the eastern half of the site. However, the site will be surveyed before final selection of sample locations. The borings will be constructed using the standard procedure in Appendix B.1. Logs of the physical characteristics of the borings will be made using the standard procedure for field characterization of material in Appendix B.1. No samples of the subsurface material will be sent to a soils testing laboratory for additional physical assessments (e.g., most soils laboratories are not licensed to handle radioactive materials; however, the HEI laboratory is licensed if assessments are required).

Tentative arrangements have been made to use Fox Drilling of Itasca, Illinois, to perform drilling and sampling services for the borings. RAE and HEI have experience with Fox Drilling working on similar projects and Fox Drilling has extensive experience in working with similar materials at the West Chicago Rare Earths Facility.

3.3.1 Gamma Logging Boreholes

PVC well casing will be placed in the borings to keep them open for gamma logging. Gamma logging will be performed using the RAE standard logging procedure in Appendix B.1. The gamma logs will be used to ensure that borings have been advanced below the areas of contaminated material. The logging will be performed with a NaI detector (or equivalent) using an instrument with a scaler. Measurements will be taken at one-foot increments, or closer spacing. The well casing will be removed prior to backfilling the boreholes.

3.3.2 Sampling of Boreholes

One or more samples will be collected from each boring using the standard sampling procedures in Appendix B.1. The objective will be to sample continuously and then select about a two-foot section of material for a sample for analysis. It is anticipated that a 3-inch diameter split-spoon/split-barrel sampler will be used. Other sampling equipment; such as, Shelby-tube, 2-inch diameter split barrel, and CME samplers will be available. However, based on the expected characteristics of the material (i.e., building debris) and the required quantity of sample (i.e., RCRA characteristics and radionuclides, and split samples with EPA), it is anticipated that a 3-inch split-barrel device will be the most successful sampler.

The section of core for samples will be based on a radiation survey and physical characteristics of the sample material. The tendency will be to exclude large debris based on agreement with the EPA representative. The selected material will be mixed in stainless-steel dishes, or similar containers, to provide material for the required sample aliquots.

The samples to be collected are identified in Table 1. The objective will be to collect two samples from several boreholes.

3.3.3 Analysis of Samples

The samples will be analyzed for RCRA characteristics and radionuclides. All samples will be analyzed by gamma spectroscopy for gamma emitting radionuclides and selected samples will be analyzed for uranium and thorium by radiochemistry and alpha spectroscopy

3.3.3.1 Analysis for Radionuclides

The radioactive decay schemes for uranium and thorium are given in Figures 5 and 6. Although all of the isotopes in the decay series do not emit gamma photons, results from the gamma emitting radioisotopes and the relationships of the decay products can be used to determine the presence of the primary radioisotopes in these decay series. The results from

Table 1. Field Investigation samples.

Type Sample	Location	Analyses to Be Performed								
		TCLP	Corrosvity	Ignitability	Reactivity	Th/U-Chm	U iso.	Gamma Sp U & Th+D	Rad Chem Ra226/28	SDWA Metals
Borings	1-Max Exp.									
	a	1	1	1	1	1	--	1	--	--
	b	--	--	--	--	--	--	1	--	--
	2-Max Exp.									
	a	1	1	1	1	1	--	1	--	--
	b	--	--	--	--	--	--	1	--	--
	3-Near Booth									
	a	1	--	--	--	1	--	1	--	--
	b	--	--	--	--	--	--	1	--	--
	4-Optional									
	a	1	--	--	--	1	--	1	--	--
	b	--	--	--	--	--	--	1	--	--
	5-Bkgd									
	a	1	1	1	1	1	--	1	--	--
	b	--	--	--	--	1	--	1	--	--
Groundwater										
	I	--	--	--	--	--	1	--	1	1
	II	--	--	--	--	--	1	--	1	1
	III	--	--	--	--	--	1	--	1	1
	IV	--	--	--	--	--	1	--	1	1
Blanks										
Boring Equip		2	--	--	--	--	--	1	--	--
Solid Blank		1	--	--	--	--	--	1	--	--
Solid QA Spike		--	--	--	--	1	--	1	1	--
Water Samp Equip		--	--	--	--	--	1	--	1	1
Water Blank		--	--	--	--	--	1	--	1	1
Trip Blanks		1	--	--	--	--	--	--	1	1
Totals		9	3	3	3	7	6	13	8	7
									Total Analyses	59

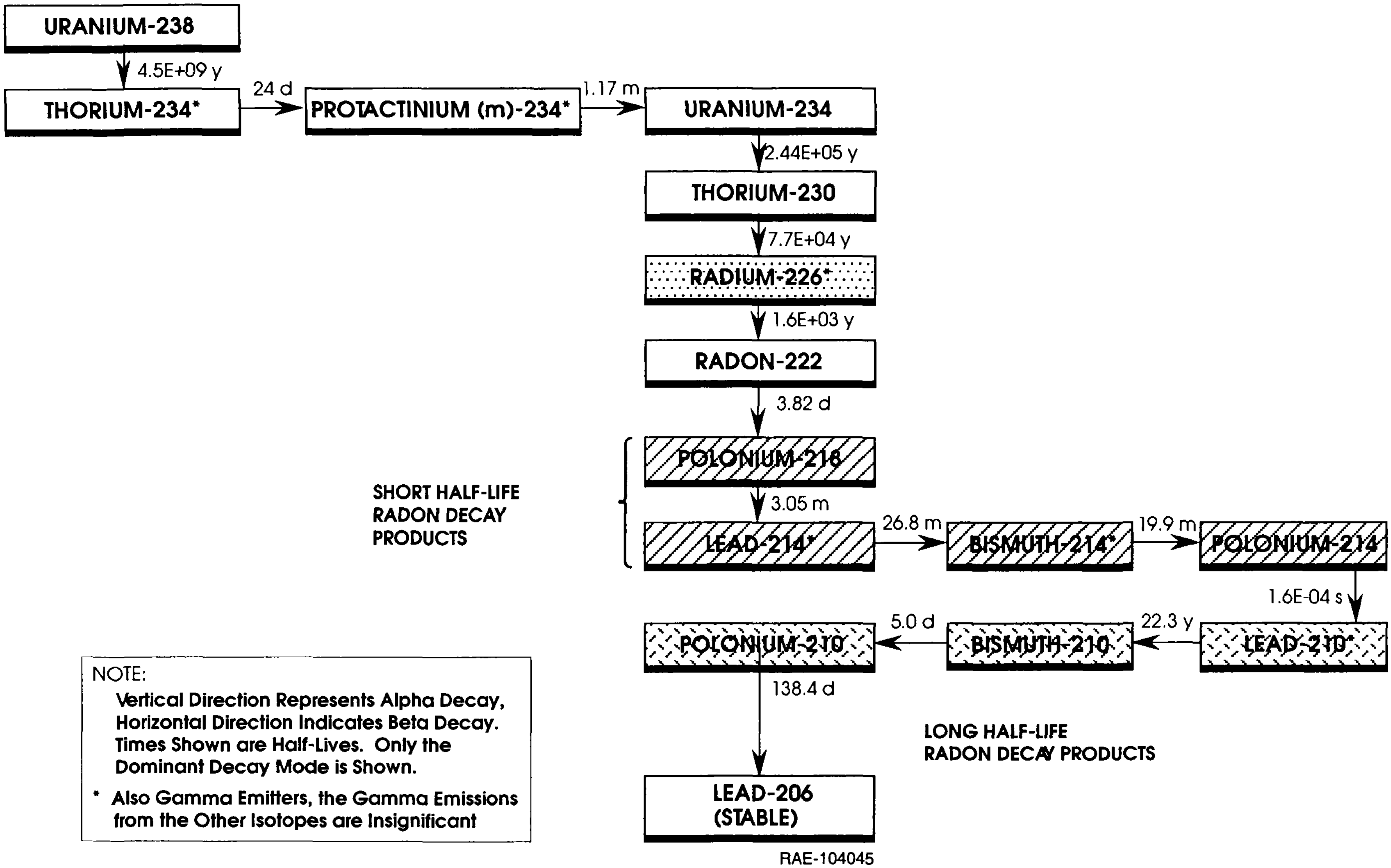

Figure 5. Uranium decay chain.

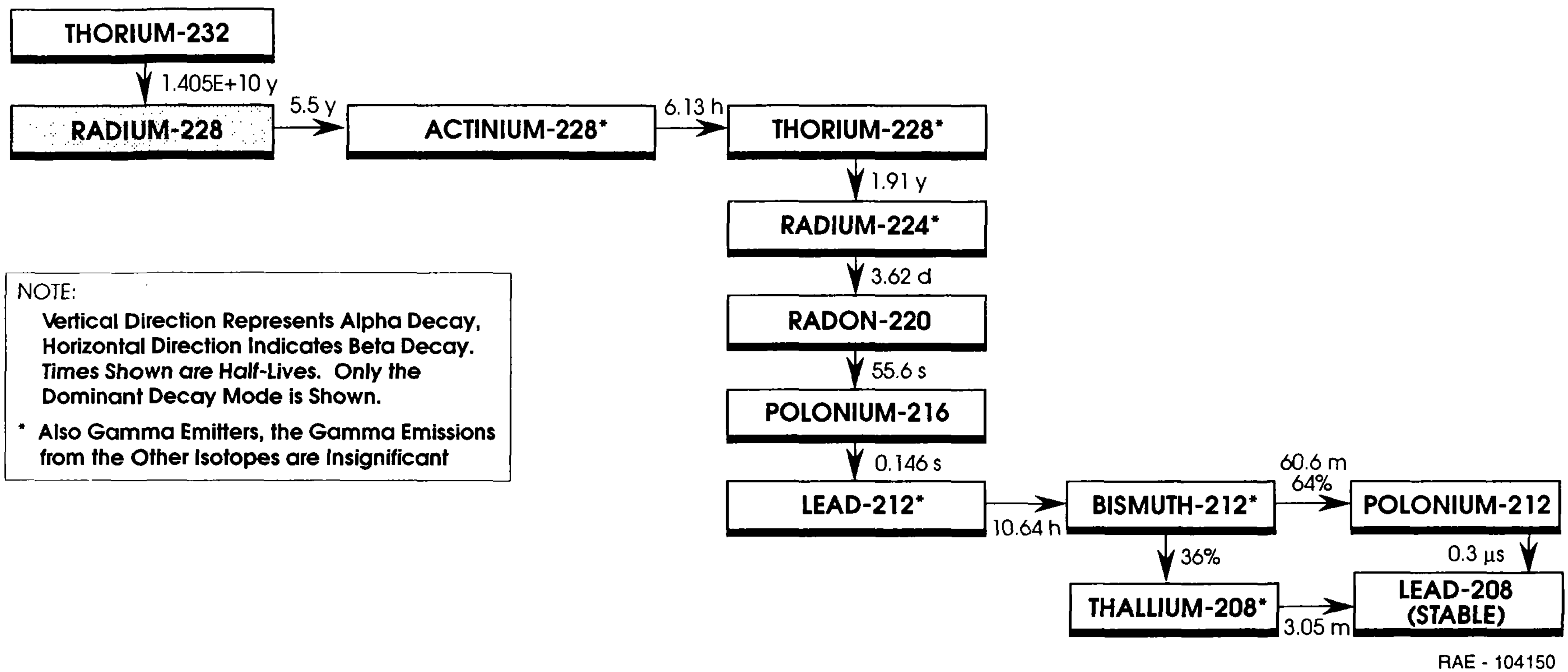

Figure 6. Thorium decay chain.

this approach will also be supplemented by the results from radiochemistry for uranium and thorium.

Gamma spectrum analysis will be performed primarily for Bi-214 and Pb-214 for the U-238 decay chain, and Ac-228 and Tl-208 for the Th-232 decay chain (see Figures 5 and 6). From these analyses and the relationships of radionuclides in the decay chains, the concentrations of Ra-226 and Ra-228 will be determined. The concentrations of U-238 and Th-232 can also be inferred from these results, but because of possible disequilibrium of the radioisotopes in the decay chains due to past chemical processing, there will be uncertainties in the U-238 and Th-232 estimates. Information on the samples and associated analyses is summarized in Table 2.

The concentrations of U-238, U-234, U-235, Th-232, and Th-228 in selected samples will be determined by radiochemistry and alpha spectroscopy in selected samples. The samples to be analyzed are identified in Table 1. The radiochemistry analyses will be performed using standard methods applied by the selected commercial laboratory. The uranium analyses will be performed using EPA Method 908 or a similar method. The samples will be analyzed by Barringer Laboratories of Golden, Colorado, or a similar laboratory. These results will be used to validate or revise the estimates of uranium and thorium obtained by gamma spectroscopy analyses. Information on samples to be analyzed by radiochemistry is given in Table 2.

Algorithms from previous environmental assessments will be used for initial evaluations of the borehole gamma logs (x pCi/g = 0.0015 * m counts/min-3). The final correlations for the borehole gamma logs will be based on correlations with the gamma spectroscopy results for Ra-226 and Ra-228, as described in the standard procedure in Appendix B.1. PVC monitoring well casing will be used to case the holes during gamma logging.

3.3.3.2 Analysis for RCRA Characteristics

Samples from the borings will be analyzed for Resource Conservation and Recovery Act (RCRA) characteristics using the methods from SW846 (EPA86). Samples will be

Table 2. Number of samples and analytical techniques.

		Samples			QA/QC SAMB			
Final @0730 Analysis	With \$ Method	Soil	Water	Subtotal	Trip Blanks	Field Blanks	QA Spikes	Total Analysis
SDWA Metals	EPA 6010\7000	--	4	4	1	1	1	7
TCLP [8240,8270,6010,7000]	SW846\1311	5	--	5	1	2	--	8
		1	--	1				1
Corrosivity	EPA 9045	3	--	3	NA	NA	--	3
Ignitibility	EPA 1010	3	--	3	NA	NA	--	3
Reactivity	EPA 9010/9030	3	--	3	NA	NA	--	3
Rad Chem								
Ra-226\228	SM 705 & EPA 904.0	--	4	4	1	1	2	8
U & Th	EPA 908.0 & USAEC RMO-3008	6	--	6	--	--	1	7
Uranium Iso	EPA 908.0	--	4	4	--	1	2	7
RAE Gamma Spec								0
U & Th +D	See App. B.1	10	--	10	NA	1	1	12
								0
SUBTOTALS		**31**	**12**	**43**	**3**	**6**	**7**	**59**

analyzed for the RCRA characteristics of corrosivity, ignitibility, and toxicity. The analyses for toxicity will be performed using the TCLP procedure, Method 1311. The extract from Method 1311 will be analyzed using Methods 8240, 8270, and 7000. These analyses include volatile organic compounds (VOC), semi-volatile organic compounds, and RCRA metals. The TCLP tests will not include the analyses for pesticides and herbicides, based on the history of the site. Table 2 indicates the samples that will be collected and the specified analytical methods.

3.4 GROUNDWATER SAMPLES

Four groundwater monitoring wells were installed during a site assessment in mid 1992. These wells are secured with surface closures. A review of the completion information (STS92) indicates they have been properly constructed and capped. The information on the construction of the wells is given in Appendix E of the Work Plan.

The wells will be sampled using the standard procedures in Appendix B.1. Water elevation measurements will be made using the standard procedures in Appendix B.1 and the well will be bailed prior to sampling. Samples will be analyzed for metals, radium-226 and radium-228, and uranium using the analytical procedures identified in Table 2. The samples will be filtered in the field and preserved per the method requirements of SW 846.

3.5 QA/QC OF SAMPLES

The collection of field and trip blank samples and other QA/QC samples is indicated in Table 2. Laboratory blank and method spike samples will be analyzed as specified by the applicable methods of SW846 (EPA86).

3.6 SPECIFICATION OF SAMPLING, ANALYTICAL METHODS AND CONTAINERS

Tables 3 to 9 provide summaries of the specific samples that will be collected at each location, the methods to be used for analysis, appropriate sample containers, requirements for preservatives, and holding times. QA samples that are to be collected/shipped with the samples from the various locations are also indicated. These "work sheets" provide the specific directions for field personnel for collection of the samples and for the required analyses of samples. This information shall be used for filling out the chain-of-custody sheets preparing shipments of samples and specifying the required sample analyses.

Table 3 provides the sampling requirements for Boring 1. The actual sample number will include the prefix "51" for a specific designation within the RAE sampling system. The location will be designated as "B1" for boring number 1. The two samples at this location will be designated as A and B. The depth interval from which they are taken will be given on the boring log and recorded on the chain-of-custody sheet. For example, the first sample from boring number 1 will be designated 51-B1A. The related containers and specified analyses will be indicated on related lines of the chain-of-custody sheet. If only one sample is taken from a borehole, an alpha-numeric character will not be used.

Tables 3 to 7 identify the requirements for sampling the five borings. The QA samples related to each boring are indicated on the pertinent sheets. Table 8 provides a summary of the QA samples and indicates which group to samples they should be collected with and shipped with. Vermiculite will be used for preparing field blank samples for the equipment used to sample the borings. After decontaminating the sampling equipment, a reasonable quantity of vermiculite will be interfaced with the sampling equipment, similar to the way a sample would interface with the equipment. Solid vermiculite will provide a more realistic medium for compacting the sampling equipment than water. It is anticipated that the samples will be sent to the laboratory in two or more shipments, to ensure timely transmittal to the laboratory.

Table 9 provides the specifications for the samples from the groundwater monitoring wells. The required QA samples are also indicated. Monitoring wells will be designated using the RAE program code "51" and the STS designation. For example, 51-xxx, where xxx is the STS location code from the figures in Appendix E.

Table 3. Sampling and analysis plan for Boring 1 (high exposure).

Samples #1-A	Samples #1-B	Analysis	Analytical Method	Sample Container Soil	Holding Time
x	-	TCLP	1311;8240,8270,6010,7000	250 ml Brown Jar Teflon Seal	7/40 days
x	-	Corrosivity	EPA 9045	250 ml jar	14 days
x	-	Ignitibility	EPA 1010	Use Corros. jar	14 days
x	-	Reactivity	EPA 9010/9030	Use Corros. jar	14 days
		Rad Chem			
x	-	U & Th	EPA 908.0 & USAEC RMO-3008	Use TCLP Cont.	6 mo
		RAE Gamma Spec			
x	x	U & Th +D	See App. B.1	Zip Lk Bag 300 g	6 mo
QA Samples					
Trip Blank	-	TCLP	1311;8240,8270,6010,7000	1-liter jar	7/40 days
Field Blank (Use vermiculite)	-	TCLP	1311;8240,8270,6010,7000	250 ml Brown Jar Teflon Seal	7/40 days
Field Blank (Use vermiculite)	-	U & Th +D	See App. B.1	Zip Lk Bag 300 g	6 mo

Trip blank and field blank samples are related to Boring #1 to ensure that the samples are collected/shipped with these samples.

Table 4. Sampling and analysis plan for Boring 2 (high exposure).

Samples #1-A	Samples #1-B	Analysis	Analytical Method	Sample Container Soil	Holding Time
x	-	TCLP	1311;8240,8270,6010,7000	250 ml Brown Jar Teflon Seal	7/40 days
x	-	Corrosivity	EPA 9045	250 ml jar	14 days
x	-	Ignitibility	EPA 1010	Use Corros. jar	14 days
x	-	Reactivity	EPA 9010/9030	Use Corros. jar	14 days
		Rad Chem			
x	-	U & Th	EPA 908.0 & Th	Use TCLP Cont.	6 mo
		RAE Gamma Spec			
x	x	U & Th +D	See App. B.1	Zip Lk Bag 300 g	6 mo

Table 5. Sampling and analysis plan for Boring 3, near booth.

Samples #1-A	Samples #1-B	Analysis	Analytical Method	Sample Container Soil	Holding Time
x	-	TCLP	1311;8240,8270,6010,7000	250 ml Brown Jar Teflon Seal	7/40 days
		Rad Chem			
x	-	U & Th	EPA 908.0 & USAEC RMO-3008	Use TCLP Cont.	
		RAE Gamma Spec			
x	x	U & Th +D	See App. B.1	Zip Lk Bag 300 g	

Table 6. Sampling and analysis plan for Boring 4, optional.

Samples					
#1-A	#1-B	Analysis	Analytical Method	Sample Container Soil	Holding Time
x	-	TCLP	1311;8240,8270,6010,7000	250 ml Brown Jar Teflon Seal	7/40 days
		Rad Chem			
x	-	U & Th	EPA 908.0 & USAEC RMO-3008	Use TCLP Cont.	6 mo
		RAE Gamma Spec			
x	x	U & Th +D	See App. B.1	Zip Lk Bag 300 g	6 mo

Table 7. Sampling and analysis plan for Boring 5, background location.

Samples					
#1-A	#1-B	Analysis	Analytical Method	Sample Container Soil	Holding Time
x	-	TCLP	1311;8240,8270,6010,7000	250 ml Brown Jar Teflon Seal	7/40 days
x	-	Corrosivity	EPA 9045	250 ml jar	14 days
x	-	Ignitibility	EPA 1010	Use Corros. jar	14 days
x	-	Reactivity	EPA 9010/9030	Use Corros. jar	14 days
		Rad Chem			
x	x	U & Th	EPA 908.0 & USECA RMO-3008	Use TCLP Cont.	6 mo
		RAE Gamma Spec			
x	x	U & Th +D	See App. B.1	Zip Lk Bag 300 g	6 mo
QA Samples					
Field Blank (Use vermiculite)	-	TCLP	1311;8240,8270,6010,7000	250 ml Brown Jar Teflon Seal	7/40 days

Field blank sample is used for background location to ensure definition of background TCLP results.

Table 8. QA samples related to borings.

Related to Sample	QA Samples	Analysis	Analytical Method	Sample Container Soil	Holding Time
1	Trip Blank	TCLP	1311;8240,8270,6010,7000	1-liter jar	7/40 days
1	Field Blank (Use vermiculite)	TCLP	1311;8240,8270,6010,7000	250 ml Brown Jar Teflon Seal	7/40 days
1	Field Blank (Use vermiculite)	U & Th +D	See App. B.1	Zip Lk Bag 300 g	6 mo
1	QA Spike	U & Th	EPA 908.0 & USAEC RMO-3008	Zip Lk Bag 300 g	6 mo
1	QA Spike	U & Th +D	See App. B.1	Zip Lk Bag 300 g	6 mo
5	Field Blank (Use vermiculite)	TCLP	1311;8240,8270,6010,7000	250 ml Brown Jar Teflon Seal	7/40 days
5	Solid Blank (Use vermiculite)	TCLP	1311;8240,8270,6010,7000	250 ml Brown Jar Teflon Seal	7/40 days

Table 9. Sampling and analysis plan for 4 monitoring wells.

Samples	Analysis	Analytical Method	Sample Container Soil	Holding Time
4-wells	Radiochemistry U isotopic	EPA 908.0	1 l plastic	30 days
4-wells	Ra-226&228	EPA 903.1 EPA 904.0 mod	2-liter plastic or 2 1-liter	30 days
4-wells	SDWA Metals	EPA 6010\7000	1-liter plastic	6 mo
QA Samples				
Trip Blank	Ra-226&228	EPA 903.1 EPA 904.0 mod	2-liter plastic or 2 1-liter	30 days
Trip Blank	SDWA Metals	EPA 6010\7000	2-liter plastic	6 mo
QA Blind Blank	U isotopic	EPA 908.0	1 l plastic	30 days
	Ra-226&228	EPA 903.1 EPA 904.0 mod	2-liter plastic or 2 1-liter	30 days
	SDWA Metals	EPA 6010\7000	1-liter plastic	6 mo
Field Blank	U isotopic	EPA 908.0	1 l plastic	30 days
	Ra-226&228	EPA 903.1 EPA 904.0 mod	2-liter plastic or 2 1-liter	30 days
	SDWA Metals	EPA 6010\7000	1-liter plastic	6 mo
Blind Spike (solid)	Ra-226&228	EPA 903.1 EPA 904.0 mod	20 grams in small container	6 mo

- Lab to add preservative to all containers prior to shipping.
- All samples from wells filtered in field.

3.7 SAMPLE MANAGEMENT

Samples will be collected using chain-of-custody procedures. The samples will be stored under chain-of-custody and cooled as specified by SW 846 (EPA86). The samples will be shipped to the RAE Laboratory in Salt Lake City, Utah, and Barringer Laboratories in Golden, Colorado, by Federal Express. An alternate laboratory (accepted by EPA and Chicago Dock) may be used. The samples will be shipped daily or every other day to ensure compliance with sample holding times. Copies of the chain-of-custody sheets will be made available to the EPA.

RAE will analyze samples by gamma spectrum analysis as specified by the procedure in Appendix B.1. Barringer Laboratory will perform the RCRA characterization analyses and radiochemistry analyses using their standard procedures and the EPA methods denoted in Tables 3 to 9.

3.8 CLOSURE OF BORINGS

The auger cuttings and sample material not retained for samples will be placed in the borehole after completion of the gamma logging. The boreholes will then be backfilled with neat cement or bentonite to within about one foot of the surface, and will then be sealed with concrete to the surface. If a borehole collapses before backfilling, it will be backfilled using the above procedure to the extent possible. In any case, all boreholes will be sealed to the surface with about one foot of concrete.

4. DECONTAMINATION OF EQUIPMENT

Decontamination of equipment will be performed onsite, in an area constructed to collect the water. The decontamination procedures are given in Appendix B.2. The sampling equipment will be decontaminated using a steam cleaner and non-phosphate detergent. Equipment will be double rinsed with deionized/distilled water. Acetone will be used prior to the rinse with deionized water, if required by the materials found on site.

The decontamination water and water from preparing the monitoring wells for sampling will be collected for off-site disposal. The water will be assayed for gross beta and gross alpha activity and screened for volatile organic compounds. It is anticipated that the water will be cleared for discharge to the municipal sewer.

5. QUALITY ASSURANCE AND QUALITY CONTROL

The Field Investigation Activities will be performed in accordance with the QAPP and the standard procedures in Appendix B.1. Field instruments will be calibrated in accordance with the procedures in Appendix B.1 and recommendations of the manufacturers. Radiation survey instruments will be calibrated by a qualified laboratory (i.e., Bicron Instruments, Ludlum Instruments, and Far West Technology, Health Physics Instruments of Goleta, California). Appropriate cross-check measurements will be made with EPA.

The quality assurance (QA) and quality control (QC) for sample analysis will be in accord with SW 846 and the QA plans of the appropriate laboratory. Field blank and trip blank samples are identified in Table 2. A solid blank and water blank will also be submitted blind to the laboratory. Appropriate spiked or blank samples from EPA will also be submitted as "blind" samples to the appropriate laboratories.

The data quality objectives are to obtain viable analyses for all of the specified samples. Duplicate samples have not been designated because of the projected difficulty of obtaining sufficient material for the designated samples. Samples of "blank" solids and water will be submitted as blind samples to the laboratory as part of the QA program. Material spiked with a known quantity of uranium and thorium (obtained from U.S. EPA, EMSL Las Vegas QA program) will also be included with the samples. Furthermore, splits of essentially all samples will be submitted to EPA for analysis. The data quality objectives for laboratory spiked samples specified in SW 846 will be as specified for the methods. The results from the blind blank and spiked samples will be used to assess the validity of the laboratory analytical data.

5.1 DATA VALIDATION

The analytical data will be evaluated for compliance with the applicable analytical procedures and QA specifications of SW 846. The assessments will include evaluating compliance with applicable sample holding times and analysis of appropriate matrix spike samples. The presence of analytes in blank samples will be used to evaluate the validity of reported data for field samples.

A CLP (contract laboratory) data package is not being specified. However, the laboratory will be required to report analytical holding times, the results of matrix spikes and matrix spike duplicates, and blank samples. The full data package and associated data validation assessments will be included in the Field Investigation Report.

6. SITE SECURITY

The property is in downtown Chicago in a commercial area. The site is an active parking lot which services businesses in the adjoining area. The use of all or portions of the property by the public will be terminated during the investigation activities in order to expedite the completion of work and minimize the potential of exposure to the public. In any case operations on the site will be managed to minimize: the potential of any off-site release, the exposure to people on the site, and advertent or inadvertent interaction of the public with contaminated materials on the site.

It may be necessary to allow access of the public to sections of the property throughout the investigation. To effectively perform the investigation, minimum areas of one-fourth of the property will be isolated from public access. After completion of the gamma survey, areas for subsurface sampling will be isolated from public access to allow safe and expeditious performance of the work.

Under no circumstances will borings or material from the subsurface be left unattended. All borings and subsurface material will be isolated when project personnel or security guards are not present. Borings may be isolated by covering the surface opening or by leaving the auger in the boring. Isolation of material may be provided by placing material in drums and locking the drums in a trailer. The trailer would be "disabled" or secured to facilities to prevent removal of the trailer from the site.

7. MANAGEMENT OF RESIDUALS FROM SAMPLE COLLECTION

Residual sample material will be collected and the water from decontamination of equipment and purging the monitoring wells prior to sampling will be collected. To the extent possible, all auger drillings and solid materials from sampling will be placed in boreholes prior to closing them. Residual material will be placed in liners in drums. The drums will be stored by the driller or Chicago Dock, pending determination of closure actions for the site.

The water from decontamination of equipment and purging the monitoring wells will be placed in drums. After completion of the field phase, the water will be sampled and samples sent to Barringer Laboratories for gross alpha and beta analysis. It is anticipated that the water can then be discharged to the municipal sewer.

REFERENCES

STS92 STS Consultants Ltd., Report of Environmental Investigation. STS Project No. 27313-XH, September 29, 1992.

EPA86 U.S. Environmental Protection Agency, Test Methods for Evaluating Solid Waste. Office of Solid Waste and Emergency Response, PB88-239223, SW-846, Third Edition, September 1986.

APPENDIX B.1

STANDARD SAMPLING AND ANALYSIS PROCEDURES

1. RAE Laboratory Procedure for Analysis of Samples for Ra-226 and Ra-228, and Associated Radionuclides.
2. RAE Procedure for Gamma Logging Boreholes to Determine the Concentration of Ra-226 and Ra-228 and other Gamma Emitting Radionuclides.
3. Standard Practice for Soil Investigation and Sampling by Auger Borings.
4. Standard Test Method for Penetration Test and Split-Barrel Sampling of Soils.
5. Standard Practice for Description and Identification of Soils (Visual-Manual Procedure).
6. Standard Test Method for Determining Subsurface Liquid Levels in a Borehole or Monitoring Well (Observation Well).

RAE PROCEDURE FOR GAMMA LOGGING BOREHOLES TO DETERMINE THE CONCENTRATION OF RA-226 AND RA-228 AND OTHER GAMMA EMITTING RADIONUCLIDES

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RAE PROCEDURE FOR GAMMA LOGGING BOREHOLES TO DETERMINE THE CONCENTRATION OF RA-226 AND RA-228 AND OTHER GAMMA EMITTING RADIONUCLIDES

1.0 PURPOSE

This procedure is used to gamma log (survey) boreholes to determine the concentration of radionuclides in the soil adjoining the borehole. The procedure is based on using calibration factors from prior experience, theoretical calibration factors, or factors developed from the analysis of samples from the boreholes. Where, the calibration factor is:

Concentration in pCi/g: count per minute

2.0 APPLICABILITY

The procedure is used to determine the vertical profile of radionuclides in sub-surface soil. The method primarily detects radionuclides within about one foot of the borehole, due to the attenuation of gamma radiation in the soil. The basic procedure is similar to that used to commonly used to characterize the sub-surface environment when drilling wells. It is common to make measurements of the gamma emissions in wells to determine changes in the stratigraphy, based on the different concentrations of naturally occurring uranium, thorium, and potassium in different formations.

This procedure applies the concepts of gamma logging of borings to obtain the concentrations of radionuclides present in the formations, and minimize the need for detailed sampling. A calibration plot is made of gamma counts versus the concentrations of the subject radionuclides in selected samples taken from the borings. The calibration plot can be obtained from laboratory analysis of samples from the site being studied or derived by other means. The objective is to obtain extensive information on the vertical distribution of the subject radionuclides without having to obtain samples from the full vertical profile for all borings.

3.0 DEFINITIONS

Calibration factor: pCi/g of subject radionuclide per count per minute.

4.0 REFERENCES

Rogers and Associates Engineering Corporation, Standard Quality Assurance Procedures.

5.0 DISCUSSION

None.

6.0 RESPONSIBILITY

The Task Leader performing the work is responsible for obtaining properly calibrated instruments and using field check sources to verify the instruments are operating correctly.

The Project Manager or designee shall provide overview of the operations and review the field data. The Project Manager shall provide the specifications concerning the depth increments for making measurements and the required statistical accuracy (i.e., counting time and the associated counting error) for the project.

The QA Officer shall audit the procedures and results to determine proper QA procedures have been used.

7.0 EQUIPMENT

- Electronic scaler for providing integral counts of detected radiation. The instrument shall be a Ludlum Model 2200, Model 2220, or equivalent. An instrument with a scaler should be used.
- Radiation detector; 1-inch NaI, or similar detector. May use 0.5-inch or smaller detector for small casing sizes.
- Printer for scaler readout, if applicable.
- High voltage cables for detectors, with a sufficient length for down-hole measurements.
- Field check sauce to ensure proper operation of the system.

- Cable or cord with measured increments for determining the position of the detector in the boring.

- PVC casing for the boring, with an inside diameter sufficiently large for insertion of the radiation detector.

- Bound log book for recording information.

- Tape recorder, optional, for recording supplemental or back-up information.

- Computer or calculator and appropriate software for reduction of data.

- Camera, optional, for documenting site and operations.

8.0 PROCEDURE

8.1 CASING OF BORING

Borings may be cased with PVC (preferably light schedule) prior to logging, or in stable formations it may not be necessary to case them. It is preferable that the casing be capped on the lower end to prevent the infusion of liquids from the formation. However, if the detector is either protected by sealing it or there is not infusion of liquids, a cap is not needed. The specifications for the boring; e.g., whether it is cased, the type of casing, and whether liquids are present shall be recorded to allow adjusting the calibration factor to the specific conditions.

It is desirable that fluids not be present in the casing, since they will attenuate the radiation from the formation. If fluids are present, it shall be noted, and if possible special calibrations made for conversion of the detector signal to concentration of radioactivity.

8.2 MEASUREMENTS

The detector (e.g., 1-inch NaI) shall be connected to the recording instrument (e.g., Ludlum 2200) and checked with a check source to ensure proper calibration. The length of cable and reading of the check source shall be recorded to allow proper normalization of the data for different cables (e.g., long cables can degrade the signal from the detector for some instruments).

The detector shall be inserted in the boring and measurements made at the specified depth increments. Measurements are normally taken at 1-foot depth increments, but this may be adjusted based on the project specifications. The counting time shall be adjusted to ensure a minimum accumulation of 1000 counts, to provide a one-sigma statistical error of 3 percent (square root of counts) or less. The actual counting time shall be based on the specifications for the project. The counting time at different depths and the depth increments at which measurements are made can be adjusted to the observed results. All information shall be fully recorded to prevent mis-interpretation of results.

8.3 DETERMINATION OF CALIBRATION FACTOR

The calibration factor is determined by comparing the gamma log values with samples taken from the associated sample depths. A least-squares analysis is performed with the gamma log values as "y" and the laboratory analytical values as "x." The correlation coefficient for the data shall be obtained. When possible sufficient calibration points should be obtained to obtain a correlation coefficient of 0.8 or higher. The degree of correlation will depend on the varying ratio of radionuclides in the formations (e.g., ratio of Ra-226 and Ra-228, variations in the amount of K-40), the elevation of concentrations of the radionuclides above average earth crust values of about 1 pCi/g, and variations in the density and moisture content of the geological strata.

RAE LABORATORY PROCEDURE FOR ANALYSIS OF SAMPLES FOR RA-226 AND RA-228, AND ASSOCIATED RADIONUCLIDES

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RAE LABORATORY PROCEDURE FOR ANALYSIS OF SAMPLES FOR RA-226 AND RA-228, AND ASSOCIATED RADIONUCLIDES

1.0 PURPOSE

This procedure is used for determining the content of the subject radionuclides in samples.

2.0 APPLICABILITY

The procedure is used for environmental samples which can be analyzed without chemical separations and radiochemical procedures.

3.0 DEFINITIONS

None.

4.0 REFERENCES

Nielson, K.K., R.Y. Bowser, V.C. Rogers, "Laboratory Procedures for Testing Samples of DOE-UMTRA Cover Soils and Uranium Mill Tailings." Rogers and Associates Engineering Corp., RAE-8944-1, 1990.

Rogers and Associates Engineering Corporation, Standard Quality Assurance Procedures.

5.0 DISCUSSION

None.

6.0 RESPONSIBILITY

The Project Manager or designee shall provide chain-of-custody sheet and/or other written information defining the required analyses of the sample. The Laboratory Technician shall receive samples, indicating receipt in writing, maintain proper custody of the samples, and perform the sample preparation, analysis, and calculation of results.

The Project Manager or designee shall review the laboratory results for data quality objectives.

The QA Officer shall audit the procedures and results to determine proper QA procedures and standard analytical procedures have been used.

7.0 EQUIPMENT

- Radiation survey instruments to screen the activity of samples.
- Oven or furnace, with proper temperature control, for drying samples.
- Properly calibrated balance with an accuracy of 0.1 g or better for weighing samples.
- Appropriate cans and sealer or canner for sealing samples, in the same geometry as standards, for analysis.
- NaI detector system, with shield and multi-channel gamma spectrum analyzer for counting samples.
- GeLi detector system, with shield and multi-channel gamma spectrum analyzer for counting samples.
- Computer and appropriate software for reduction of data.

8.0 PROCEDURE

8.1 SAMPLE PREPARATION

The sample is mixed together to assure uniformity and to break up any large clumps of material. If more material is available than fits into the assay can, mixing is particularly important for representative sampling. For sand-slime tailings mixtures, the sand and slime are often separated. It is important in these cases that a proportionate volume of each be used in the final test sample. Mixing can often be achieved by kneading the sample directly in its plastic sample bag.

If the test moisture is not specified and/or the sample moisture is more than 10% or above the specified test moisture, the sample may be taken out of the bag and mixed. The sample is placed in a metal pan and large clumps are broken up using a spatulá or small scoop. The sample is mixed by hand, working the sample until all clumps are of similar size and proportion. Grain sizes should not be reduced significantly during this procedure. Any special mixing performed on samples should be noted on the data sheets.

If a test moisture has been specified, a moisture check is performed to determine the present moisture. This is done by placing a small aliquot of the total sample (50-100 grams) into a tared beaker. The sample is then dried by microwave or convection oven until constant weight is achieved, and the moisture is calculated as in Equation (1). If the measured moisture content is above the specified moisture content, the sample is placed in a metal bowl and allowed to dry by open-air evaporation, or is placed in a drying oven at 110°C.

$$M = 100(W_1 - W_2) / (W_2 - W_c) + 100\ W_w/W_s \qquad (1)$$

where

M = Moisture content, (% dry wt)

W_1 = Mass of beaker and moist specimen, g

W_2 = Mass of beaker and oven-dried specimen, g

W_c = Mass of beaker, g

W_w = Mass of water, g

W_s = Mass of solid particles, g.

Metal cans (8.2-cm diameter x 5.1-cm) and lids are used to contain the sample. The cans (1/2-pound cans and lids or equivalent) and sealing apparatus are available from Embarcadero Home Cannery, Oakland, CA. The can and lid are labeled with the appropriate sample number and weighed. Their combined weight is recorded. The sample is packed into the can by taking scoops of sample material and pressing them into the can. The can is filled to within about 0.5-1 cm from the top of the can. If additional moisture is required, the amount of water to be added is calculated as

$$W_{add} = W_{samp} \, (M_{test} - M) \, / \, (100 + M) \qquad (2)$$

where

W_{add} = Mass of water to be added to the sample (g)

W_{samp} = Net mass of moist sample in can (g)

M_{test} = desired test moisture (%, dry wt. basis)

M = Measured sample moisture (%, dry wt. basis).

The can lid is placed on the filled can, and both are placed in the sealing apparatus and sealed. The date and time of sealing and the total weight of the sample are recorded. The sample can is then stored for 30 days to obtain equilibrium of the radon decay products, or for at least 24 days if mathematical equilibrium corrections are applied. Before analysis, the sample is leak-tested by squeezing the can ends together, under water, and verifying the absence of any bubbles released during squeezing.

8.2 GAMMA COUNTING SYSTEM

The gamma counting system used for the radium and radon emanation measurements consists of a 5-inch diameter, 3-inch thick thallium- activated sodium iodide crystal [NaI(Tl)] gamma spectrometer obtained from Harshaw Chemical Co., Solon, OH. The detector is mounted inside a cylindrical shield containing 0.5-inches of steel and 3-inches of lead to reduce background. An annular positioning ring is located on the face of the detector to assist in centering of sample cans placed on the detector surface.

The gamma spectrometer is operated by a multichannel analyzer (Series 30, Canberra, Inc., Meriden, CT, or equivalent) that supplies bias high voltage (1 kV) and an appropriate pre-amp and amplifier. The detector gain is adjusted such that the 609-keV Bi-214 peak is centered in channel 40, and can be totally included in a 7- to 9-channel window. The multichannel analyzer regions of interest are used to define and integrate appropriate peak areas. The multichannel analyzer is connected to a digital printer for recording of results, and also may be connected to a computer for disk storage of either the integrated counting data or of entire spectra. Background count rates are determined weekly during active periods, or more often if background count rates correspond to >0.3 pCi/g. Background counts utilize a low-radium quartz sample in standard geometry, counted for >700 minutes.

A similar procedure is used for the GeLi system, but since there is much better resolution of energies more extensive analyses can be performed. Table 1 shows an example data sheet. The Ra-226 is based on the average of the results from the Bi-214 and Pb-214 gamma peaks. Ra-228 is based on the Ac-228 results.

8.3 CALIBRATION AND DAILY CHECK

Sample counting is always preceded by a daily check of the gamma spectrometer and a calibration count. The spectrometer check involves placing a sealed-can radium standard on the center of the detector face and acquiring a one-minute spectrum. The position of the photopeaks is visually checked for proximity to the required channels. If it is not centered at the required position, the spectrometer is adjusted using the amplifier fine-gain control. Centering is adjusted and new spectra are acquired. A 2- to 10-minute spectrum then is acquired. Regions of interest are entered into the multichannel analyzer memory to define the peak window and background regions. The same gain, channels, and windows are used for all sample counts as for the standard.

Printout of any gamma assay is performed on a digital printer or a computer disk file. Each printout is preceded by entry of the sample or standard identification, the date and time of the count, and any pertinent comments. Upon count termination, the integrated gamma intensities are printed. Digital data from the entire spectrum or from the regions of interest also may be printed, but are not required.

The following calculations are used for Ra-226 for the NaI system. The calculations are similar for other radionuclides and for the GeLi system.

.. I.D. NO. : IM17-9.SPM
SAMPLE MASS (g) : 300.4
DATE : 11/13/92
COUNT TIME (sec): 1800
..OMETRY : CN

Table 1

*** PEAK REPORT ***

Nuclide	Gamma Energy (keV)	ROI Beg. Chan / ROI End. Chan	Net Counts / Background Counts	Conc. (pCi/g) / Uncert. (pCi/g)	Percent Uncert. / LLD (pCi/g)	Absorp. Correct. / System Bkgd
U-235	143.80	506	4	0.145	879.935	0.970
		520	473	1.277	1.275	0
Ra-226	186.20	656	225	24.292	15.842	0.972
		674	523	3.848	3.487	2
Pb-214	351.90	1245	1355	26.110	3.079	0.977
		1268	190	0.804	0.375	6
Tl-208	510.80	1811	41	5.628	36.649	0.980
		1832	84	2.063	1.764	20
.l-208	583.10	2070	26	1.091	57.651	0.981
		2090	99	0.629	0.588	2
Bi-214	609.30	2163	888	25.213	3.571	0.981
		2185	55	0.900	0.298	7
Cs-137	661.60	2340	92	1.513	16.283	0.982
		2385	64	0.246	0.187	4
Bi-212	727.20	2584	7	1.505	138.561	0.983
		2602	42	2.086	1.990	1
Tl-208	860.40	3058	10	4.209	92.958	0.984
		3077	40	3.913	3.669	1
Ac-228	911.10	3238	16	1.133	61.936	0.985
		3260	41	0.702	0.637	1
Ac-228	968.00	3432	21	1.877	52.795	0.985
		3465	48	0.991	0.891	2
Pa-234	1001.00	3560	-5	-19.040	-144.331	0.986
		3578	29	27.480	28.634	1

$$A_{net} = C_{peak} - (C_{b1} + C_{b2})\, n_p / n_b \tag{3}$$

where

A_{net} = Net counts in the 609 keV peak

C_{peak} = Counts in the peak window

C_{b1} = Counts in the lower background window

C_{b2} = Counts in the upper background window

n_p = Number of channels in the peak window

n_b = Total number of channels in background windows 1 & 2.

The uncertainty in the net peak area is computed as

$$U_{Anet} = C_{peak} + (C_{b1} + C_{b2})\, (n_p / n_b)^2 \tag{4}$$

where

U_{Anet} = One-sigma uncertainty in A_{net}.

After computing the net area of the peak from the standard, a normalization factor is computed (for the VT-1 standard, it equals 17597 divided by the net area and the count time for the standard). This is used as a multiplier to normalize subsequent gamma counts. The radium standard should be counted within 4 hours of a given sample count to determine its normalization and to accommodate possible system drifts.

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Standard Practice for Soil Investigation and Sampling by Auger Borings[1]

This standard is issued under the fixed designation D 1452; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

This standard has been approved for use by agencies of the Department of Defense. Consult the DoD Index of Specifications and Standards for the specific year of issue which has been adopted by the Department of Defense.

$^{\epsilon 1}$ NOTE—Section 6 was added editorially in July 1990.

1. Scope

1.1 This practice covers equipment and procedures for the use of earth augers in shallow geotechnical exploration. This practice does not apply to sectional continuous flight augers.

1.2 *This standard does not purport to address the safety problems associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Significance and Use

2.1 Auger borings often provide the simplest method of soil investigation and sampling. They may be used for any purpose where disturbed samples can be used and are valuable in connection with ground water level determination and indication of changes in strata and advancement of hole for spoon and tube sampling. Equipment required is simple and readily available. Depths of auger investigations are, however, limited by ground water conditions, soil characteristics, and the equipment used.

3. Apparatus

3.1 *Hand-Operated Augers*:

3.1.1 *Helical Augers*—Small lightweight augers generally available in sizes from 1 through 3 in. (25.4 through 76.2 mm).

3.1.1.1 *Spiral-Type Auger*, consisting of a flat thin metal strip, machine twisted to a spiral configuration of uniform pitch; having at one end, a sharpened or hardened point, with a means of attaching a shaft or extension at the opposite end.

3.1.1.2 *Ship-Type Auger*—Similar to a carpenter's wood bit. It is generally forged from steel and machined to the desired size and configuration. It is normally provided with sharpened and hardened nibs at the point end and with an integral shaft extending through its length for attachment of a handle or extension at the opposite end.

3.1.2 *Open Tubular Augers*, ranging in size from 1.5 through 8 in. (38.1 through 203.2 mm) and having the common characteristic of appearing essentially tubular when viewed from the digging end.

3.1.2.1 *Orchard-Barrel Type*, consisting essentially of a tube having cutting lips or nibs hardened and sharpened to penetrate the formation on one end and an adaptor fitting for an extension or handle on the opposite end.

3.1.2.2 *Open-Spiral Type*, consisting of a flat thin metal strip that has been helically wound around a circular mandrel to form a spiral in which the flat faces of the strip are parallel to the axis of the augered hole. The lower helix edges are hard-faced to improve wear characteristics. The opposite end is fitted with an adaptor for extension.

3.1.2.3 *Closed-Spiral Type*—Nearly identical to the open-spiral type except, the pitch of the helically wound spiral is much less than that of the open-spiral type.

3.1.3 *Post-Hole Augers*, generally 2 through 8 in. (50.8 through 203.2 mm), and having in common a means of blocking the escape of soil from the auger.

3.1.3.1 *Clam-Shell Type*, consisting of two halves, hinged to allow opening and closing for alternately digging and retrieving. It is not usable deeper than about 3.5 ft (1.07 m).

3.1.3.2 *Iwan Type*, consisting of two tubular steel segments, connected at the top to a common member to form a nearly complete tube, but with diametrically opposed openings. It is connected at the bottom by two radial blades pitched to serve as cutters which also block the escape of contained soil. Attachment of handle or extension is at the top connector.

3.2 *Machine-Operated Augers*:

3.2.1 *Helical Augers*, generally 8 through 48 in. (203.2 through 1219 mm), consisting essentially of a center shaft fitted with a shank or socket for application of power, and having one to three complete 360° (6.28-rad) spirals for conveyance and storage of cut soil. Cutter bits and pilot bits are available in moderate and hard formation types and normally replaceable in the field. They are normally operated by heavy-duty, high-torque machines, designed for heavy construction work.

3.2.2 *Stinger Augers*, generally 6 through 30 in. (152.4 through 762 mm), are similar to the helical auger in 3.2.1, but lighter and generally smaller. They are commonly operated by light-duty machines for post and power pole holes.

3.2.3 *Disk Augers*, generally 10 through 30 in. (254 through 762 mm), consisting essentially of a flat, steel disk with diametrically opposed segments removed and having a

[1] This practice is under the jurisdiction of ASTM Committee D-18 on Soil and Rock and is the direct responsibility of Subcommittee D18.02 on Sampling and Related Field Testing for Soil Investigations.

Current edition approved June 12, 1980. Published August 1980. Originally published as D 1452 – 57 T. Last previous edition D 1452 – 65 (1972).

shank or socket located centrally for application of power. Replaceable cutter bits, located downward from the leading edges of the remaining disk, dig and load soil that is held on the disk by valves or shutters hinged at the disk in order to close the removed segments. The disk auger is specifically designed to be operated by machines having limited vertical clearance between spindle and ground surface.

3.2.4 *Bucket Auger*, generally 12 through 48 in. (304.8 through 1219 mm), consisting essentially of a disk auger, without shank or socket, but hinge-mounted to the bottom of a steel tube or bucket of approximately the same diameter as the disk auger. A socket or shank for power application is located in the top center of the bucket diametral cross piece provided for the purpose.

3.3 *Casing* (when needed), consisting of pipe of slightly larger diameter than the auger used.

3.4 *Accessory Equipment*—Labels, field log sheets, sample jars, sealing wax, sample bags, and other necessary tools and supplies.

4. Procedure

4.1 Make the auger boring by rotating and advancing the desired distance into the soil. Withdraw the auger from the hole and remove the soil for examination and test. Return the empty auger to the hole and repeat the procedure. Continue the sequence until the required depth is reached.

4.2 Casing is required in unstable soil in which the bore hole fails to stay open and especially when the boring is extended below the ground-water level. The inside diameter of the casing must be slightly larger than the diameter of the auger used. The casing shall be driven to a depth not greater than the top of the next sample and shall be cleaned out by means of the auger. The auger can then be inserted into the bore hole and turned below the bottom of the casing to obtain a sample.

4.3 The soil auger can be used both for boring the hole and for bringing up disturbed samples of the soil encountered. The structure of a cohesive soil is completely destroyed and the moisture may be changed by the auger. Seal all samples in a jar or other airtight container and label appropriately. If more than one type of soil is picked up in the sample, prepare a separate container for each type of soil.

4.4 *Field Observations*—Record complete ground water information in the field logs. Where casing is used, measure ground water levels, both before and after the casing is pulled. In sands, determine the water level at least 30 min after the boring is completed; in silts, at least 24 h. In clays, no accurate water level determination is possible unless pervious seams are present. As a precaution, however, water levels in clays shall be taken after at least 24 h.

5. Report

5.1 The data obtained in boring shall be recorded in the field logs and shall include the following:

5.1.1 Date of start and completion of boring,

5.1.2 Identifying number of boring,

5.1.3 Reference datum including direction and distance of boring relative to reference line of project or other suitable reference points,

5.1.4 Type and size of auger used in boring,

5.1.5 Depth of changes in strata,

5.1.6 Description of soil in each major stratum,

5.1.7 Ground water elevation and location of seepage zones, when found, and

5.1.8 Condition of augered hole upon removal of auger, that is, whether the hole remains open or the sides cave, when such can be observed.

6. Keywords

Auger borings; sampling; soil investigations

Designation: D 1586 – 84 (Reapproved 1992)$^{\epsilon 1}$

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Standard Test Method for Penetration Test and Split-Barrel Sampling of Soils[1]

This standard is issued under the fixed designation D 1586; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

This standard has been approved for use by agencies of the Department of Defense. Consult the DOD Index of Specifications and Standards for the specific year of issue which has been adopted by the Department of Defense.

$^{\epsilon 1}$ NOTE—Editorial changes were made throughout October 1992.

1. Scope

1.1 This test method describes the procedure, generally known as the Standard Penetration Test (SPT), for driving a split-barrel sampler to obtain a representative soil sample and a measure of the resistance of the soil to penetration of the sampler.

1.2 *This standard does not purport to address all of the safety problems, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.* For a specific precautionary statement, see 5.4.1.

1.3 The values stated in inch-pound units are to be regarded as the standard.

2. Referenced Documents

2.1 *ASTM Standards:*

D 2487 Test Method for Classification of Soils for Engineering Purposes[2]

D 2488 Practice for Description and Identification of Soils (Visual-Manual Procedure)[2]

D 4220 Practices for Preserving and Transporting Soil Samples[2]

D 4633 Test Method for Stress Wave Energy Measurement for Dynamic Penetrometer Testing Systems[2]

3. Terminology

3.1 *Descriptions of Terms Specific to This Standard*

3.1.1 *anvil*—that portion of the drive-weight assembly which the hammer strikes and through which the hammer energy passes into the drill rods.

3.1.2 *cathead*—the rotating drum or windlass in the rope-cathead lift system around which the operator wraps a rope to lift and drop the hammer by successively tightening and loosening the rope turns around the drum.

3.1.3 *drill rods*—rods used to transmit downward force and torque to the drill bit while drilling a borehole.

3.1.4 *drive-weight assembly*—a device consisting of the hammer, hammer fall guide, the anvil, and any hammer drop system.

3.1.5 *hammer*—that portion of the drive-weight assembly consisting of the 140 ± 2 lb (63.5 ± 1 kg) impact weight which is successively lifted and dropped to provide the energy that accomplishes the sampling and penetration.

3.1.6 *hammer drop system*—that portion of the drive-weight assembly by which the operator accomplishes the lifting and dropping of the hammer to produce the blow.

3.1.7 *hammer fall guide*—that part of the drive-weight assembly used to guide the fall of the hammer.

3.1.8 *N-value*—the blowcount representation of the penetration resistance of the soil. The *N*-value, reported in blows per foot, equals the sum of the number of blows required to drive the sampler over the depth interval of 6 to 18 in. (150 to 450 mm) (see 7.3).

3.1.9 ΔN—the number of blows obtained from each of the 6-in. (150-mm) intervals of sampler penetration (see 7.3).

3.1.10 *number of rope turns*—the total contact angle between the rope and the cathead at the beginning of the operator's rope slackening to drop the hammer, divided by 360° (see Fig. 1).

3.1.11 *sampling rods*—rods that connect the drive-weight assembly to the sampler. Drill rods are often used for this purpose.

3.1.12 *SPT*—abbreviation for Standard Penetration Test, a term by which engineers commonly refer to this method.

4. Significance and Use

4.1 This test method provides a soil sample for identification purposes and for laboratory tests appropriate for soil obtained from a sampler that may produce large shear strain disturbance in the sample.

4.2 This test method is used extensively in a great variety of geotechnical exploration projects. Many local correlations and widely published correlations which relate SPT blowcount, or *N*-value, and the engineering behavior of earthworks and foundations are available.

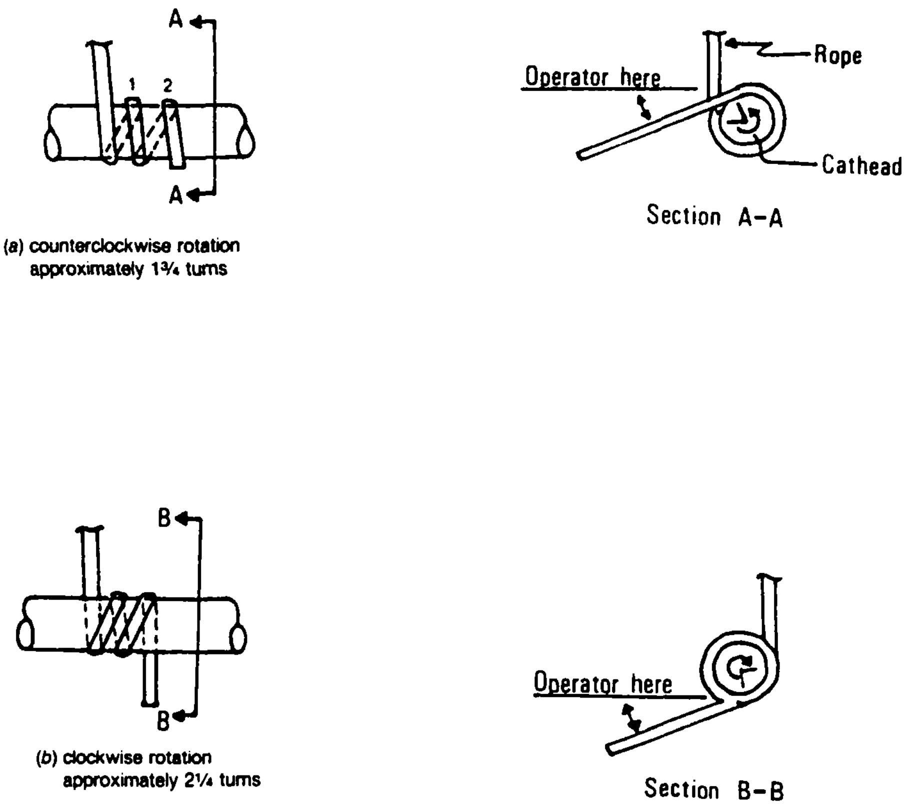
5. Apparatus

5.1 *Drilling Equipment*—Any drilling equipment that provides at the time of sampling a suitably clean open hole before insertion of the sampler and ensures that the penetration test is performed on undisturbed soil shall be acceptable. The following pieces of equipment have proven to be

[1] This method is under the jurisdiction of ASTM Committee D-18 on Soil and Rock and is the direct responsibility of Subcommittee D18.02 on Sampling and Related Field Testing for Soil Investigations.

Current edition approved Sept. 11, 1984. Published November 1984. Originally published as D 1586 – 58 T. Last previous edition D 1586 – 67 (1974).

[2] *Annual Book of ASTM Standards*, Vol 04.08.



(a) counterclockwise rotation approximately 1¾ turns

(b) clockwise rotation approximately 2¼ turns

FIG. 1 Definitions of the Number of Rope Turns and the Angle for (a) Counterclockwise Rotation and (b) Clockwise Rotation of the Cathead

suitable for advancing a borehole in some subsurface conditions.

5.1.1 *Drag, Chopping, and Fishtail Bits*, less than 6.5 in. (162 mm) and greater than 2.2 in. (56 mm) in diameter may be used in conjuction with open-hole rotary drilling or casing-advancement drilling methods. To avoid disturbance of the underlying soil, bottom discharge bits are not permitted; only side discharge bits are permitted.

5.1.2 *Roller-Cone Bits*, less than 6.5 in. (162 mm) and greater than 2.2 in. (56 mm) in diameter may be used in conjunction with open-hole rotary drilling or casing-advancement drilling methods if the drilling fluid discharge is deflected.

5.1.3 *Hollow-Stem Continuous Flight Augers*, with or without a center bit assembly, may be used to drill the boring. The inside diameter of the hollow-stem augers shall be less than 6.5 in. (162 mm) and greater than 2.2 in. (56 mm).

5.1.4 *Solid, Continuous Flight, Bucket and Hand Augers*, less than 6.5 in. (162 mm) and greater than 2.2 in. (56 mm) in diameter may be used if the soil on the side of the boring does not cave onto the sampler or sampling rods during sampling.

5.2 *Sampling Rods*—Flush-joint steel drill rods shall be used to connect the split-barrel sampler to the drive-weight assembly. The sampling rod shall have a stiffness (moment of inertia) equal to or greater than that of parallel wall "A" rod (a steel rod which has an outside diameter of 1⅝ in. (41.2 mm) and an inside diameter of 1⅛ in. (28.5 mm).

NOTE 1—Recent research and comparative testing indicates the type rod used, with stiffness ranging from "A" size rod to "N" size rod, will usually have a negligible effect on the *N*-values to depths of at least 100 ft (30 m).

5.3 *Split-Barrel Sampler*—The sampler shall be constructed with the dimensions indicated in Fig. 2. The driving shoe shall be of hardened steel and shall be replaced or repaired when it becomes dented or distorted. The use of liners to produce a constant inside diameter of 1⅜ in. (35 mm) is permitted, but shall be noted on the penetration record if used. The use of a sample retainer basket is permitted, and should also be noted on the penetration record if used.

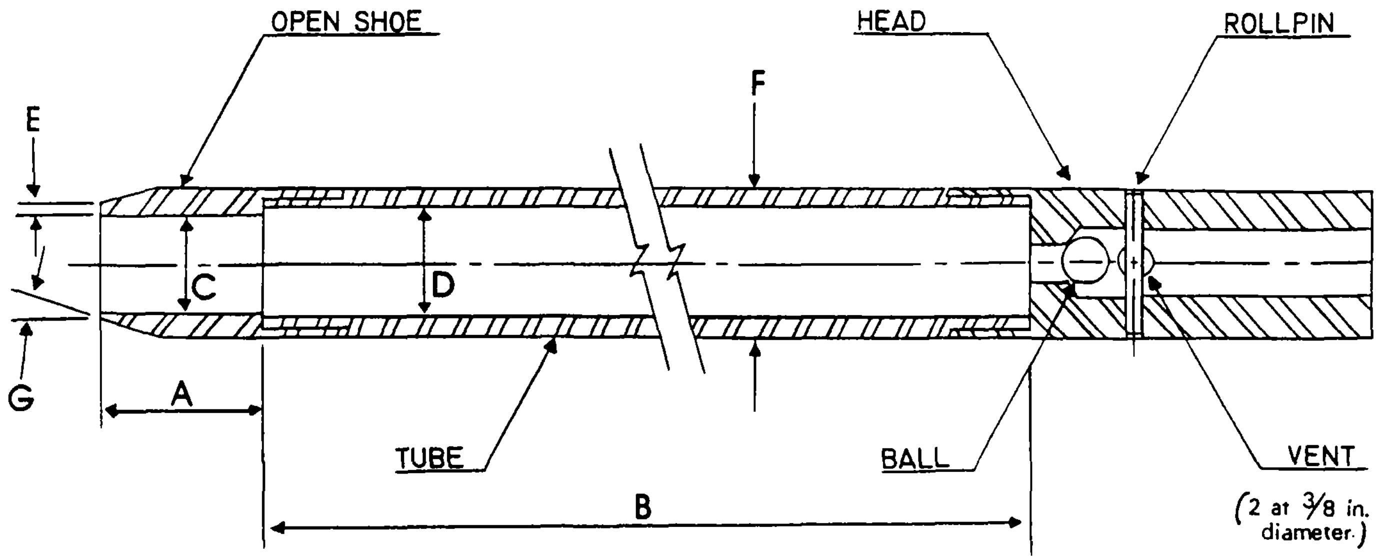
NOTE 2—Both theory and available test data suggest that *N*-values may increase between 10 to 30 % when liners are used.

5.4 *Drive-Weight Assembly:*

5.4.1 *Hammer and Anvil*—The hammer shall weigh 140 ± 2 lb (63.5 ± 1 kg) and shall be a solid rigid metallic mass. The hammer shall strike the anvil and make steel on steel contact when it is dropped. A hammer fall guide permitting a free fall shall be used. Hammers used with the cathead and rope method shall have an unimpeded overlift capacity of at least 4 in. (100 mm). For safety reasons, the use of a hammer assembly with an internal anvil is encouraged.

NOTE 3—It is suggested that the hammer fall guide be permanently marked to enable the operator or inspector to judge the hammer drop height.

5.4.2 *Hammer Drop System*—Rope-cathead, trip, semi-automatic, or automatic hammer drop systems may be used, providing the lifting apparatus will not cause penetration of



A = 1.0 to 2.0 in. (25 to 50 mm)
B = 18.0 to 30.0 in. (0.457 to 0.762 m)
C = 1.375 ± 0.005 in. (34.93 ± 0.13 mm)
D = 1.50 ± 0.05 − 0.00 in. (38.1 ± 1.3 − 0.0 mm)
E = 0.10 ± 0.02 in. (2.54 ± 0.25 mm)
F = 2.00 ± 0.05 − 0.00 in. (50.8 ± 1.3 − 0.0 mm)
G = 16.0° to 23.0°

The 1½ in. (38 mm) inside diameter split barrel may be used with a 16-gage wall thickness split liner. The penetrating end of the drive shoe may be slightly rounded. Metal or plastic retainers may be used to retain soil samples.

FIG. 2 Split-Barrel Sampler

the sampler while re-engaging and lifting the hammer.

5.5 *Accessory Equipment*—Accessories such as labels, sample containers, data sheets, and groundwater level measuring devices shall be provided in accordance with the requirements of the project and other ASTM standards.

6. Drilling Procedure

6.1 The boring shall be advanced incrementally to permit intermittent or continuous sampling. Test intervals and locations are normally stipulated by the project engineer or geologist. Typically, the intervals selected are 5 ft (1.5 mm) or less in homogeneous strata with test and sampling locations at every change of strata.

6.2 Any drilling procedure that provides a suitably clean and stable hole before insertion of the sampler and assures that the penetration test is performed on essentially undisturbed soil shall be acceptable. Each of the following procedures have proven to be acceptable for some subsurface conditions. The subsurface conditions anticipated should be considered when selecting the drilling method to be used.

6.2.1 Open-hole rotary drilling method.

6.2.2 Continuous flight hollow-stem auger method.

6.2.3 Wash boring method.

6.2.4 Continuous flight solid auger method.

6.3 Several drilling methods produce unacceptable borings. The process of jetting through an open tube sampler and then sampling when the desired depth is reached shall not be permitted. The continuous flight solid-auger method shall not be used for advancing the boring below a water table or below the upper confining bed of a confined non-cohesive stratum that is under artesian pressure. Casing may not be advanced below the sampling elevation prior to sampling. Advancing a boring with bottom discharge bits is not permissible. It is not permissible to advance the boring for subsequent insertion of the sampler solely by means of previous sampling with the SPT sampler.

6.4 The drilling fluid level within the boring or hollow-stem augers shall be maintained at or above the in situ groundwater level at all times during drilling, removal of drill rods, and sampling.

7. Sampling and Testing Procedure

7.1 After the boring has been advanced to the desired sampling elevation and excessive cuttings have been removed, prepare for the test with the following sequence of operations.

7.1.1 Attach the split-barrel sampler to the sampling rods and lower into the borehole. Do not allow the sampler to drop onto the soil to be sampled.

7.1.2 Position the hammer above and attach the anvil to the top of the sampling rods. This may be done before the sampling rods and sampler are lowered into the borehole.

7.1.3 Rest the dead weight of the sampler, rods, anvil, and drive weight on the bottom of the boring and apply a seating blow. If excessive cuttings are encountered at the bottom of the boring, remove the sampler and sampling rods from the boring and remove the cuttings.

7.1.4 Mark the drill rods in three successive 6-in. (0.15-m) increments so that the advance of the sampler under the impact of the hammer can be easily observed for each 6-in. (0.15-m) increment.

7.2 Drive the sampler with blows from the 140-lb (63.5-

') hammer and count the number of blows applied in each '. (0.15-m) increment until one of the following occurs:

7.2.1 A total of 50 blows have been applied during any one of the three 6-in. (0.15-m) increments described in 7.1.4.

7.2.2 A total of 100 blows have been applied.

7.2.3 There is no observed advance of the sampler during the application of 10 successive blows of the hammer.

7.2.4 The sampler is advanced the complete 18 in. (0.45 m) without the limiting blow counts occurring as described in 7.2.1, 7.2.2, or 7.2.3.

7.3 Record the number of blows required to effect each 6 in. (0.15 m) of penetration or fraction thereof. The first 6 in. is considered to be a seating drive. The sum of the number of blows required for the second and third 6 in. of penetration is termed the "standard penetration resistance," or the "*N*-value." If the sampler is driven less than 18 in. (0.45 m), as permitted in 7.2.1, 7.2.2, or 7.2.3, the number of blows per each complete 6-in. (0.15-m) increment and per each partial increment shall be recorded on the boring log. For partial increments, the depth of penetration shall be reported to the nearest 1 in. (25 mm), in addition to the number of blows. If the sampler advances below the bottom of the boring under the static weight of the drill rods or the weight of the drill rods plus the static weight of the hammer, this information should be noted on the boring log.

7.4 The raising and dropping of the 140-lb (63.5-kg) hammer shall be accomplished using either of the following two methods:

7.4.1 By using a trip, automatic, or semi-automatic hammer drop system which lifts the 140-lb (63.5-kg) hammer and allows it to drop 30 ± 1.0 in. (0.76 m ± 25 mm) unimpeded.

7.4.2 By using a cathead to pull a rope attached to the hammer. When the cathead and rope method is used the system and operation shall conform to the following:

7.4.2.1 The cathead shall be essentially free of rust, oil, or grease and have a diameter in the range of 6 to 10 in. (150 to 250 mm).

7.4.2.2 The cathead should be operated at a minimum speed of rotation of 100 RPM, or the approximate speed of rotation shall be reported on the boring log.

7.4.2.3 No more than 2¼ rope turns on the cathead may be used during the performance of the penetration test, as shown in Fig. 1.

NOTE 4—The operator should generally use either 1¾ or 2¼ rope turns, depending upon whether or not the rope comes off the top (1¾ turns) or the bottom (2¼ turns) of the cathead. It is generally known and accepted that 2¾ or more rope turns considerably impedes the fall of the hammer and should not be used to perform the test. The cathead rope should be maintained in a relatively dry, clean, and unfrayed condition.

7.4.2.4 For each hammer blow, a 30-in. (0.76-m) lift and drop shall be employed by the operator. The operation of pulling and throwing the rope shall be performed rhythmically without holding the rope at the top of the stroke.

7.5 Bring the sampler to the surface and open. Record the percent recovery or the length of sample recovered. Describe the soil samples recovered as to composition, color, stratification, and condition, then place one or more representative portions of the sample into sealable moisture-proof containers (jars) without ramming or distorting any apparent stratification. Seal each container to prevent evaporation of soil moisture. Affix labels to the containers bearing job designation, boring number, sample depth, and the blow count per 6-in. (0.15-m) increment. Protect the samples against extreme temperature changes. If there is a soil change within the sampler, make a jar for each stratum and note its location in the sampler barrel.

8. Report

8.1 Drilling information shall be recorded in the field and shall include the following:

8.1.1 Name and location of job,

8.1.2 Names of crew,

8.1.3 Type and make of drilling machine,

8.1.4 Weather conditions,

8.1.5 Date and time of start and finish of boring,

8.1.6 Boring number and location (station and coordinates, if available and applicable),

8.1.7 Surface elevation, if available,

8.1.8 Method of advancing and cleaning the boring,

8.1.9 Method of keeping boring open,

8.1.10 Depth of water surface and drilling depth at the time of a noted loss of drilling fluid, and time and date when reading or notation was made,

8.1.11 Location of strata changes,

8.1.12 Size of casing, depth of cased portion of boring,

8.1.13 Equipment and method of driving sampler,

8.1.14 Type sampler and length and inside diameter of barrel (note use of liners),

8.1.15 Size, type, and section length of the sampling rods, and

8.1.16 Remarks.

8.2 Data obtained for each sample shall be recorded in the field and shall include the following:

8.2.1 Sample depth and, if utilized, the sample number,

8.2.2 Description of soil,

8.2.3 Strata changes within sample,

8.2.4 Sampler penetration and recovery lengths, and

8.2.5 Number of blows per 6-in. (0.15-m) or partial increment.

9. Precision and Bias

9.1 *Precision*—A valid estimate of test precision has not been determined because it is too costly to conduct the necessary inter-laboratory (field) tests. Subcommittee D18.02 welcomes proposals to allow development of a valid precision statement.

9.2 *Bias*—Because there is no reference material for this test method, there can be no bias statement.

9.3 Variations in *N*-values of 100 % or more have been observed when using different standard penetration test apparatus and drillers for adjacent borings in the same soil formation. Current opinion, based on field experience, indicates that when using the same apparatus and driller, *N*-values in the same soil can be reproduced with a coefficient of variation of about 10 %.

9.4 The use of faulty equipment, such as an extremely massive or damaged anvil, a rusty cathead, a low speed cathead, an old, oily rope, or massive or poorly lubricated rope sheaves can significantly contribute to differences in *N*-values obtained between operator-drill rig systems.

9.5 The variability in N-values produced by different drill rigs and operators may be reduced by measuring that part of the hammer energy delivered into the drill rods from the sampler and adjusting N on the basis of comparative energies. A method for energy measurement and N-value adjustment is given in Test Method D 4633.

10. Keywords

10.1 blow count; in-situ test; penetration resistance; split-barrel sampling; standard penetration test

AMERICAN SOCIETY FOR TESTING AND MATERIALS
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Standard Practice for Description and Identification of Soils (Visual-Manual Procedure)[1]

This standard is issued under the fixed designation D 2488; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

This standard has been approved for use by agencies of the Department of Defense. Consult the DoD Index of Specifications and Standards for the specific year of issue which has been adopted by the Department of Defense.

1. Scope

1.1 This practice covers procedures for the description of soils for engineering purposes.

1.2 This practice also describes a procedure for identifying soils, at the option of the user, based on the classification system described in Test Method D 2487. The identification is based on visual examination and manual tests. It must be clearly stated in reporting an identification that it is based on visual-manual procedures.

1.2.1 When precise classification of soils for engineering purposes is required, the procedures prescribed in Test Method D 2487 shall be used.

1.2.2 In this practice, the identification portion assigning a group symbol and name is limited to soil particles smaller than 3 in. (75 mm).

1.2.3 The identification portion of this practice is limited to naturally occurring soils (disturbed and undisturbed).

NOTE 1—This practice may be used as a descriptive system applied to such materials as shale, claystone, shells, crushed rock, etc. (See Appendix X2).

1.3 The descriptive information in this practice may be used with other soil classification systems or for materials other than naturally occurring soils.

1.4 *This standard does not purport to address all of the safety problems associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.* For specific precautionary statements see Section 8.

1.5 The values stated in inch-pound units are to be regarded as the standard.

2. Referenced Documents

2.1 *ASTM Standards:*

D 653 Terminology Relating to Soil, Rock, and Contained Fluids[2]

D 1452 Practice for Soil Investigation and Sampling by Auger Borings[2]

D 1586 Method for Penetration Test and Split-Barrel Sampling of Soils[2]

D 1587 Practice for Thin-Walled Tube Sampling of Soils[2]

D 2113 Practice for Diamond Core Drilling for Site Investigation[2]

D 2487 Test Method for Classification of Soils for Engineering Purposes[2]

D 4083 Practice for Description of Frozen Soils (Visual-Manual Procedure)[2]

3. Terminology

3.1 *Definitions:*

3.1.1 Except as listed below, all definitions are in accordance with Terminology D 653.

NOTE 2—For particles retained on a 3-in. (75-mm) US standard sieve, the following definitions are suggested:

Cobbles—particles of rock that will pass a 12-in. (300-mm) square opening and be retained on a 3-in. (75-mm) sieve, and

Boulders—particles of rock that will not pass a 12-in. (300-mm) square opening.

3.1.1.2 *clay*—soil passing a No. 200 (75-μm) sieve that can be made to exhibit plasticity (putty-like properties) within a range of water contents, and that exhibits considerable strength when air-dry. For classification, a clay is a fine-grained soil, or the fine-grained portion of a soil, with a plasticity index equal to or greater than 4, and the plot of plasticity index versus liquid limit falls on or above the "A" line (see Fig. 3 of Test Method D 2487).

3.1.1.3 *gravel*—particles of rock that will pass a 3-in. (75-mm) sieve and be retained on a No. 4 (4.75-mm) sieve with the following subdivisions:

coarse—passes a 3-in. (75-mm) sieve and is retained on a ¾-in. (19-mm) sieve.

fine—passes a ¾-in. (19-mm) sieve and is retained on a No. 4 (4.75-mm) sieve.

3.1.1.4 *organic clay*—a clay with sufficient organic content to influence the soil properties. For classification, an organic clay is a soil that would be classified as a clay, except that its liquid limit value after oven drying is less than 75 % of its liquid limit value before oven drying.

3.1.1.5 *organic silt*—a silt with sufficient organic content to influence the soil properties. For classification, an organic silt is a soil that would be classified as a silt except that its liquid limit value after oven drying is less than 75 % of its liquid limit value before oven drying.

3.1.1.6 *peat*—a soil composed primarily of vegetable tissue in various stages of decomposition usually with an organic odor, a dark brown to black color, a spongy consistency, and a texture ranging from fibrous to amorphous.

3.1.1.7 *sand*—particles of rock that will pass a No. 4

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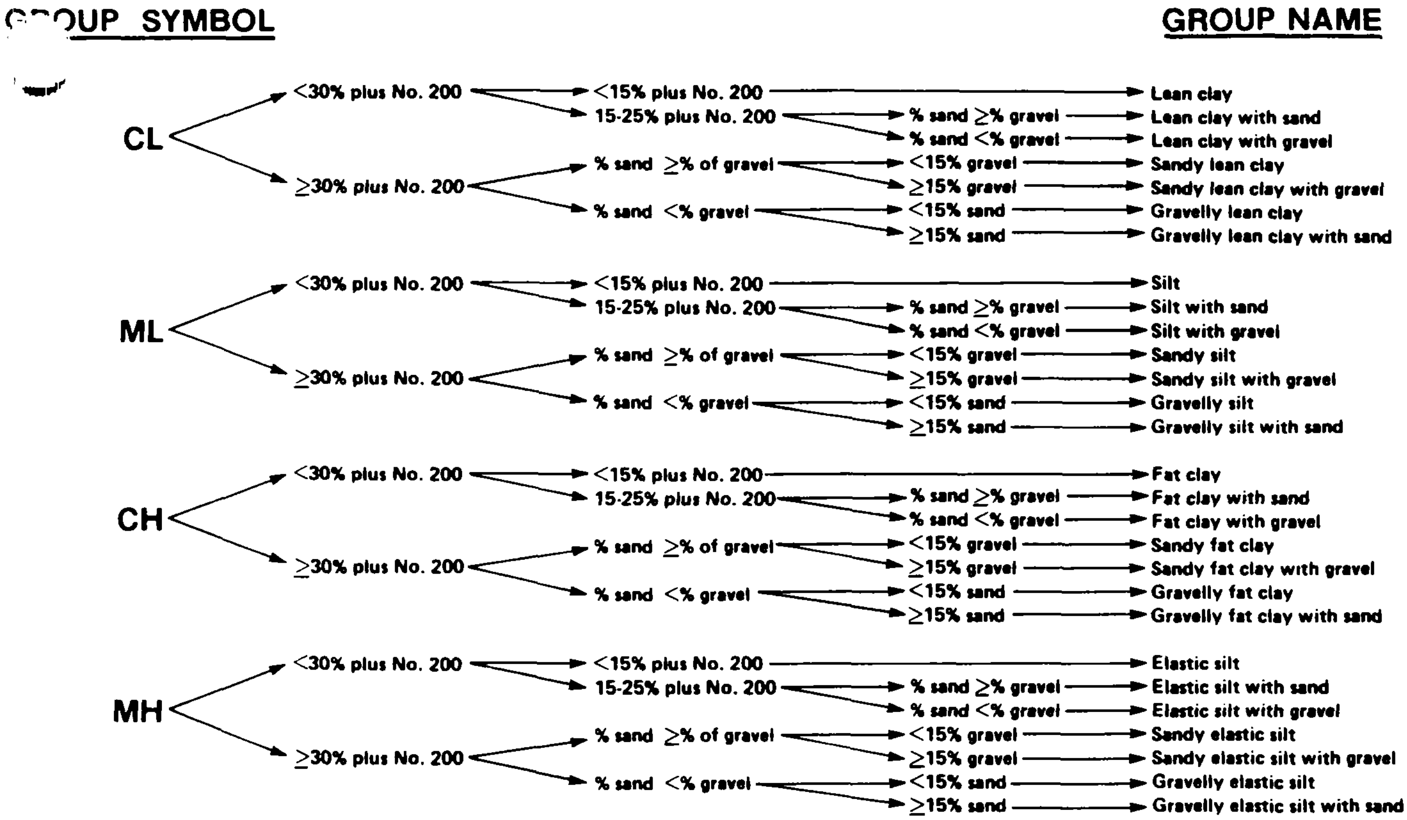
[1] This practice is under the jurisdiction of ASTM Committee D-18 on Soil and Rock and is the direct responsibility of Subcommittee D18.07 on Identification and Classification of Soils.

Current edition approved June 29, 1990. Published August 1990. Originally published as D 2488 – 66 T. Last previous edition D 2488 – 84$^{\epsilon 1}$.

[2] *Annual Book of ASTM Standards*, Vol 04.08.



TE—Percentages are based on estimating amounts of fines, sand, and gravel to the nearest 5 %.

FIG. 1a Flow Chart for Identifying Inorganic Fine-Grained Soil (50 % or more fines)

(4.75-mm) sieve and be retained on a No. 200 (75-µm) sieve with the following subdivisions:

coarse—passes a No. 4 (4.75-mm) sieve and is retained on a No. 10 (2.00-mm) sieve.

medium—passes a No. 10 (2.00-mm) sieve and is retained on a No. 40 (425-µm) sieve.

fine—passes a No. 40 (425-µm) sieve and is retained on a No. 200 (75-µm) sieve.

3.1.1.8 *silt*—soil passing a No. 200 (75-µm) sieve that is nonplastic or very slightly plastic and that exhibits little or no strength when air dry. For classification, a silt is a fine-grained soil, or the fine-grained portion of a soil, with a plasticity index less than 4, or the plot of plasticity index versus liquid limit falls below the "A" line (see Fig. 3 of Test Method D 2487).

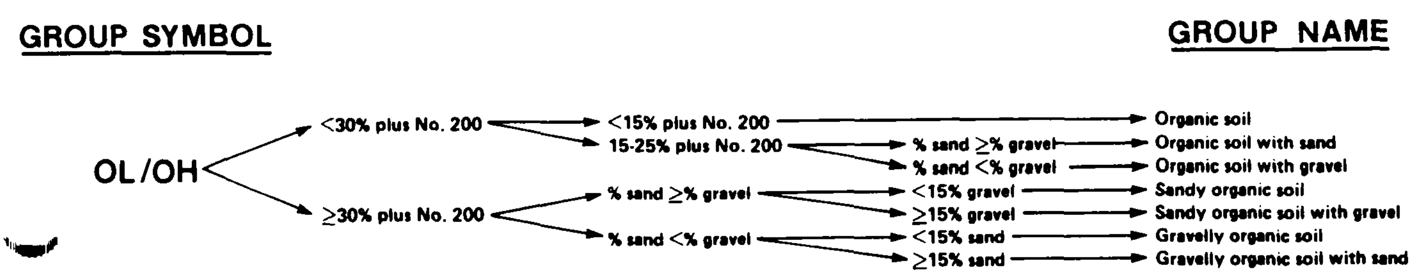
4. Summary of Practice

4.1 Using visual examination and simple manual tests, this practice gives standardized criteria and procedures for describing and identifying soils.

4.2 The soil can be given an identification by assigning a group symbol(s) and name. The flow charts, Figs. 1a and 1b for fine-grained soils, and Fig. 2, for coarse-grained soils, can be used to assign the appropriate group symbol(s) and name. If the soil has properties which do not distinctly place it into a specific group, borderline symbols may be used, see Appendix X3.

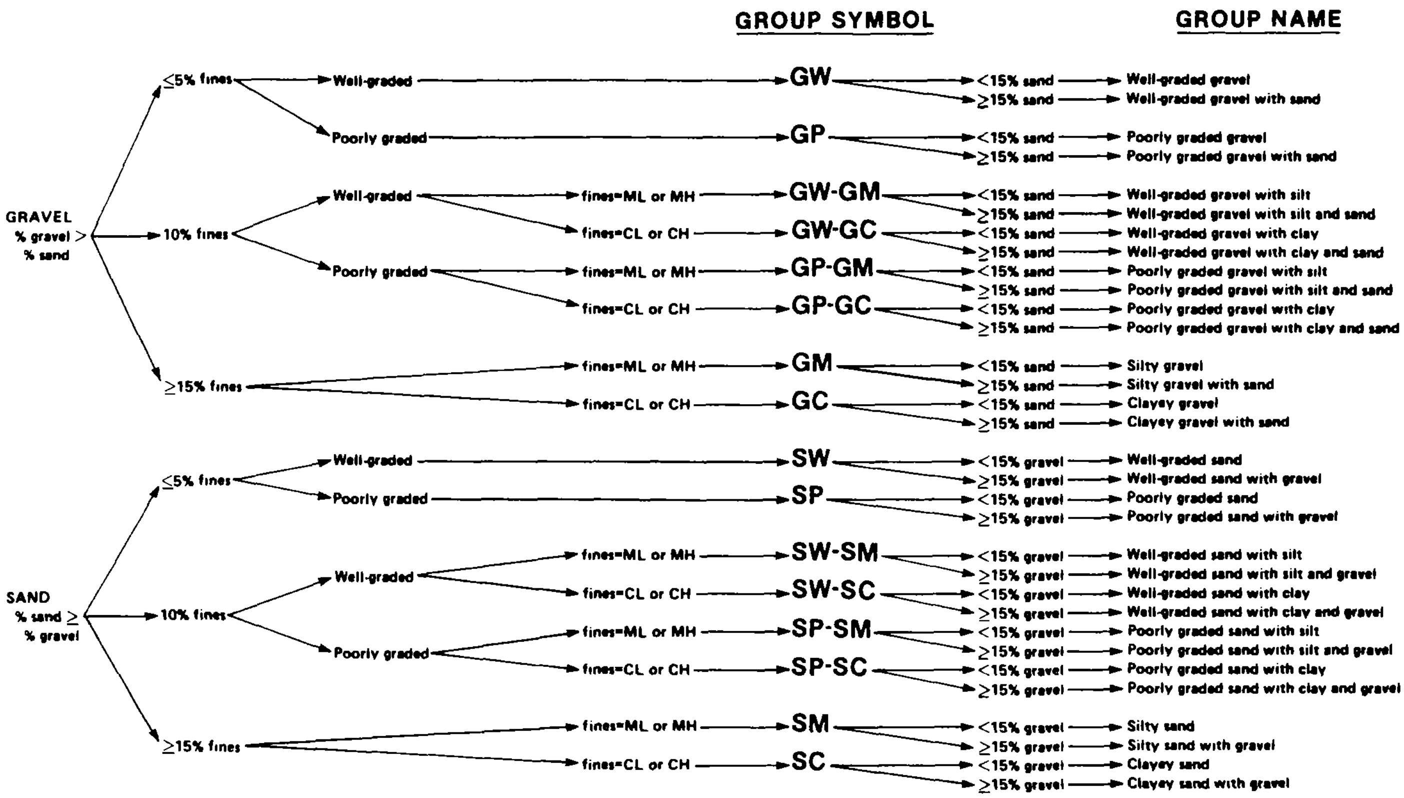
NOTE 3—It is suggested that a distinction be made between *dual symbols* and *borderline symbols.*

Dual Symbol—A dual symbol is two symbols separated by a hyphen, for example, GP-GM, SW-SC, CL-ML used to indicate that the soil has been identified as having the properties of a classification in accordance with Test Method D 2487 where two symbols are required. Two symbols are required when the soil has between 5 and 12 % fines or



NOTE—Percentages are based on estimating amounts of fines, sand, and gravel to the nearest 5 %.

FIG. 1b Flow Chart for Identifying Organic Fine-Grained Soil (50 % or more fines)



NOTE—Percentages are based on estimating amounts of fines, sand, and gravel to the nearest 5 %.

FIG. 2 Flow Chart for Identifying Coarse-Grained Soils (less than 50 % fines)

when the liquid limit and plasticity index values plot in the CL-ML area of the plasticity chart.

Borderline Symbol—A borderline symbol is two symbols separated by a slash, for example, CL/CH, GM/SM, CL/ML. A borderline symbol should be used to indicate that the soil has been identified as having properties that do not distinctly place the soil into a specific group (see Appendix X3).

5. Significance and Use

5.1 The descriptive information required in this practice can be used to describe a soil to aid in the evaluation of its significant properties for engineering use.

5.2 The descriptive information required in this practice should be used to supplement the classification of a soil as determined by Test Method D 2487.

5.3 This practice may be used in identifying soils using the classification group symbols and names as prescribed in Test Method D 2487. Since the names and symbols used in this practice to identify the soils are the same as those used in Test Method D 2487, it shall be clearly stated in reports and all other appropriate documents, that the classification symbol and name are based on visual-manual procedures.

5.4 This practice is to be used not only for identification of soils in the field, but also in the office, laboratory, or wherever soil samples are inspected and described.

5.5 This practice has particular value in grouping similar soil samples so that only a minimum number of laboratory tests need be run for positive soil classification.

NOTE 4—The ability to describe and identify soils correctly is learned more readily under the guidance of experienced personnel, but it may also be acquired systematically by comparing numerical laboratory test results for typical soils of each type with their visual and manual characteristics.

5.6 When describing and identifying soil samples from a given boring, test pit, or group of borings or pits, it is not necessary to follow all of the procedures in this practice for every sample. Soils which appear to be similar can be grouped together; one sample completely described and identified with the others referred to as similar based on performing only a few of the descriptive and identification procedures described in this practice.

5.7 This practice may be used in combination with Practice D 4083 when working with frozen soils.

6. Apparatus

6.1 *Required Apparatus:*

6.1.1 *Pocket Knife or Small Spatula.*

6.2 *Useful Auxiliary Apparatus:*

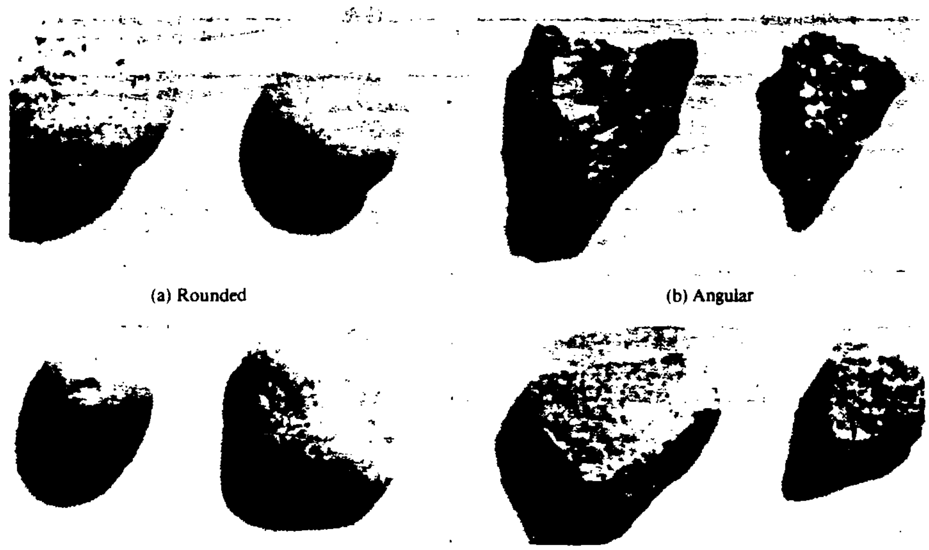
6.2.1 *Small Test Tube and Stopper* (or jar with a lid).

6.2.2 *Small Hand Lens.*

7. Reagents

7.1 *Purity of Water*—Unless otherwise indicated, references to water shall be understood to mean water from a city water supply or natural source, including non-potable water.

7.2 *Hydrochloric Acid*—A small bottle of dilute hydrochloric acid, HCl, one part HCl (10 *N*) to three parts water (This reagent is optional for use with this practice). See Section 8.



(a) Rounded (b) Angular

(c) Subrounded (d) Subangular

FIG. 3 Typical Angularity of Bulky Grains

8. Safety Precautions

8.1 When preparing the dilute HCl solution of one part concentrated hydrochloric acid (10 *N*) to three parts of distilled water, slowly add acid into water following necessary safety precautions. Handle with caution and store safely. If solution comes into contact with the skin, rinse thoroughly with water.

8.2 **Caution**—Do not add water to acid.

9. Sampling

9.1 The sample shall be considered to be representative of the stratum from which it was obtained by an appropriate, accepted, or standard procedure.

NOTE 5—Preferably, the sampling procedure should be identified as having been conducted in accordance with Practices D 1452, D 1587, or D 2113, or Method D 1586.

9.2 The sample shall be carefully identified as to origin.

NOTE 6—Remarks as to the origin may take the form of a boring number and sample number in conjunction with a job number, a geologic stratum, a pedologic horizon or a location description with respect to a permanent monument, a grid system or a station number and offset with respect to a stated centerline and a depth or elevation.

9.3 For accurate description and identification, the minimum amount of the specimen to be examined shall be in accordance with the following schedule:

Maximum Particle Size, Sieve Opening	Minimum Specimen Size, Dry Weight
4.75 mm (No. 4)	100 g (0..5 lb)
9.5 mm (3/8 in.)	200 g (0.5 lb)
19.0 mm (3/4 in.)	1.0 kg (2.2 lb)
38.1 mm (1½ in.)	8.0 kg (18 lb)
75.0 mm (3 in.)	60.0 kg (132 lb)

NOTE 7—If random isolated particles are encountered that are significantly larger than the particles in the soil matrix, the soil matrix can be accurately described and identified in accordance with the preceeding schedule.

9.4 If the field sample or specimen being examined is smaller than the minimum recommended amount, the report shall include an appropriate remark.

10. Descriptive Information for Soils

10.1 *Angularity*—Describe the angularity of the sand (coarse sizes only), gravel, cobbles, and boulders, as angular, subangular, subrounded, or rounded in accordance with the criteria in Table 1 and Fig. 3. A range of angularity may be stated, such as: subrounded to rounded.

10.2 *Shape*—Describe the shape of the gravel, cobbles, and boulders as flat, elongated, or flat and elongated if they meet the criteria in Table 2 and Fig. 4. Otherwise, do not mention the shape. Indicate the fraction of the particles that have the shape, such as: one-third of the gravel particles are flat.

10.3 *Color*—Describe the color. Color is an important property in identifying organic soils, and within a given

TABLE 1 Criteria for Describing Angularity of Coarse-Grained Particles (see Fig. 3)

Description	Criteria
Angular	Particles have sharp edges and relatively plane sides with unpolished surfaces
Subangular	Particles are similar to angular description but have rounded edges
Subrounded	Particles have nearly plane sides but have well-rounded corners and edges
Rounded	Particles have smoothly curved sides and no edges

TABLE 2 Criteria for Describing Particle Shape (see Fig. 4)

The particle shape shall be described as follows where length, width, and thickness refer to the greatest, intermediate, and least dimensions of a particle, respectively.

Flat	Particles with width/thickness > 3
Elongated	Particles with length/width > 3
Flat and elongated	Particles meet criteria for both flat and elongated

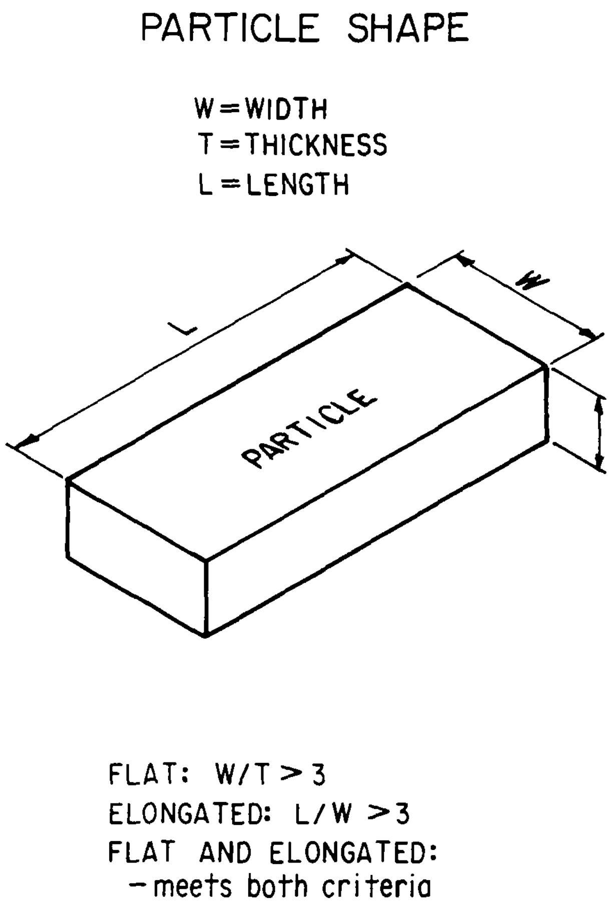


FIG. 4 Criteria for Particle Shape

TABLE 3 Criteria for Describing Moisture Condition

Description	Criteria
Dry	Absence of moisture, dusty, dry to the touch
Moist	Damp but no visible water
Wet	Visible free water, usually soil is below water table

locality it may also be useful in identifying materials of similar geologic origin. If the sample contains layers or patches of varying colors, this shall be noted and all representative colors shall be described. The color shall be described for moist samples. If the color represents a dry condition, this shall be stated in the report.

10.4 *Odor*—Describe the odor if organic or unusual. Soils containing a significant amount of organic material usually have a distinctive odor of decaying vegetation. This is especially apparent in fresh samples, but if the samples are dried, the odor may often be revived by heating a moistened sample. If the odor is unusual (petroleum product, chemical, and the like), it shall be described.

10.5 *Moisture Condition*—Describe the moisture condition as dry, moist, or wet, in accordance with the criteria in Table 3.

10.6 *HCl Reaction*—Describe the reaction with HCl as none, weak, or strong, in accordance with the critera in Table 4. Since calcium carbonate is a common cementing agent, a report of its presence on the basis of the reaction with dilute hydrochloric acid is important.

TABLE 4 Criteria for Describing the Reaction With HCl

Description	Criteria
None	No visible reaction
Weak	Some reaction, with bubbles forming slowly
Strong	Violent reaction, with bubbles forming immediately

TABLE 5 Criteria for Describing Consistency

Description	Criteria
Very soft	Thumb will penetrate soil more than 1 in. (25 mm)
Soft	Thumb will penetrate soil about 1 in. (25 mm)
Firm	Thumb will indent soil about ¼ in. (6 mm)
Hard	Thumb will not indent soil but readily indented with thumbnail
Very hard	Thumbnail will not indent soil

10.7 *Consistency*—For intact fine-grained soil, describe the consistency as very soft, soft, firm, hard, or very hard, in accordance with the criteria in Table 5. This observation is inappropriate for soils with significant amounts of gravel.

10.8 *Cementation*—Describe the cementation of intact coarse-grained soils as weak, moderate, or strong, in accordance with the criteria in Table 6.

10.9 *Structure*—Describe the structure of intact soils in accordance with the criteria in Table 7.

10.10 *Range of Particle Sizes*—For gravel and sand components, describe the range of particle sizes within each component as defined in 3.1.2 and 3.1.6. For example, about 20 % fine to coarse gravel, about 40 % fine to coarse sand.

10.11 *Maximum Particle Size*—Describe the maximum particle size found in the sample in accordance with the following information:

10.11.1 *Sand Size*—If the maximum particle size is a sand size, describe as fine, medium, or coarse as defined in 3.1.6. For example: maximum particle size, medium sand.

10.11.2 *Gravel Size*—If the maximum particle size is a gravel size, describe the maximum particle size as the smallest sieve opening that the particle will pass. For example, maximum particle size, 1½ in. (will pass a 1½-in. square opening but not a ¾-in. square opening).

10.11.3 *Cobble or Boulder Size*—If the maximum particle size is a cobble or boulder size, describe the maximum dimension of the largest particle. For example: maximum dimension, 18 in. (450 mm).

10.12 *Hardness*—Describe the hardness of coarse sand and larger particles as hard, or state what happens when the particles are hit by a hammer, for example, gravel-size particles fracture with considerable hammer blow, some gravel-size particles crumble with hammer blow. "Hard" means particles do not crack, fracture, or crumble under a hammer blow.

10.13 Additional comments shall be noted, such as the presence of roots or root holes, difficulty in drilling or augering hole, caving of trench or hole, or the presence of mica.

10.14 A local or commercial name or a geologic interpre-

TABLE 6 Criteria for Describing Cementation

Description	Criteria
Weak	Crumbles or breaks with handling or little finger pressure
Moderate	Crumbles or breaks with considerable finger pressure
Strong	Will not crumble or break with finger pressure

TABLE 7 Criteria for Describing Structure

Description	Criteria
Stratified	Alternating layers of varying material or color with layers at least 6 mm thick; note thickness
Laminated	Alternating layers of varying material or color with the layers less than 6 mm thick; note thickness
Fissured	Breaks along definite planes of fracture with little resistance to fracturing
Slickensided	Fracture planes appear polished or glossy, sometimes striated
Blocky	Cohesive soil that can be broken down into small angular lumps which resist further breakdown
Lensed	Inclusion of small pockets of different soils, such as small lenses of sand scattered through a mass of clay; note thickness
Homogeneous	Same color and appearance throughout

tation of the soil, or both, may be added if identified as such.

10.15 A classification or identification of the soil in accordance with other classification systems may be added if identified as such.

11. Identification of Peat

11.1 A sample composed primarily of vegetable tissue in various stages of decomposition that has a fibrous to amorphous texture, usually a dark brown to black color, and an organic odor, shall be designated as a highly organic soil and shall be identified as peat, PT, and not subjected to the identification procedures described hereafter.

12. Preparation for Identification

12.1 The soil identification portion of this practice is based on the portion of the soil sample that will pass a 3-in. (75-mm) sieve. The larger than 3-in. (75-mm) particles must be removed, manually, for a loose sample, or mentally, for an intact sample before classifying the soil.

12.2 Estimate and note the percentage of cobbles and the percentage of boulders. Performed visually, these estimates will be on the basis of volume percentage.

NOTE 8—Since the percentages of the particle-size distribution in Test Method D 2487 are by dry weight, and the estimates of percentages for gravel, sand, and fines in this practice are by dry weight, it is recommended that the report state that the percentages of cobbles and boulders are by volume.

12.3 Of the fraction of the soil smaller than 3 in. (75 mm), estimate and note the percentage, by dry weight, of the gravel, sand, and fines (see Appendix X4 for suggested procedures).

NOTE 9—Since the particle-size components appear visually on the basis of volume, considerable experience is required to estimate the percentages on the basis of dry weight. Frequent comparisons with laboratory particle-size analyses should be made.

12.3.1 The percentages shall be estimated to the closest 5 %. The percentages of gravel, sand, and fines must add up to 100 %.

12.3.2 If one of the components is present but not in sufficient quantity to be considered 5 % of the smaller than 3-in. (75-mm) portion, indicate its presence by the term *trace*, for example, trace of fines. A trace is not to be considered in the total of 100 % for the components.

13. Preliminary Identification

13.1 The soil is *fine grained* if it contains 50 % or more fines. Follow the procedures for identifying fine-grained soils of Section 14.

13.2 The soil is *coarse grained* if it contains less than 50 % fines. Follow the procedures for identifying coarse-grained soils of Section 15.

14. Procedure for Identifying Fine-Grained Soils

14.1 Select a representative sample of the material for examination. Remove particles larger than the No. 40 sieve (medium sand and larger) until a specimen equivalent to about a handful of material is available. Use this specimen for performing the dry strength, dilatancy, and toughness tests.

14.2 *Dry Strength:*

14.2.1 From the specimen, select enough material to mold into a ball about 1 in. (25 mm) in diameter. Mold the material until it has the consistency of putty, adding water if necessary.

14.2.2 From the molded material, make at least three test specimens. A test specimen shall be a ball of material about ½ in. (12 mm) in diameter. Allow the test specimens to dry in air, or sun, or by artificial means, as long as the temperature does not exceed 60°C.

14.2.3 If the test specimen contains natural dry lumps, those that are about ½ in. (12 mm) in diameter may be used in place of the molded balls.

NOTE 10—The process of molding and drying usually produces higher strengths than are found in natural dry lumps of soil.

14.2.4 Test the strength of the dry balls or lumps by crushing between the fingers. Note the strength as none, low, medium, high, or very high in accorance with the criteria in Table 8. If natural dry lumps are used, do not use the results of any of the lumps that are found to contain particles of coarse sand.

14.2.5 The presence of high-strength water-soluble cementing materials, such as calcium carbonate, may cause exceptionally high dry strengths. The presence of calcium carbonate can usually be detected from the intensity of the reaction with dilute hydrochloric acid (see 10.6).

14.3 *Dilatancy:*

14.3.1 From the specimen, select enough material to mold into a ball about ½ in. (12 mm) in diameter. Mold the material, adding water if necessary, until it has a soft, but not sticky, consistency.

14.3.2 Smooth the soil ball in the palm of one hand with the blade of a knife or small spatula. Shake horizontally, striking the side of the hand vigorously against the other hand several times. Note the reaction of water appearing on

TABLE 8 Criteria for Describing Dry Strength

Description	Criteria
None	The dry specimen crumbles into powder with mere pressure of handling
Low	The dry specimen crumbles into powder with some finger pressure
Medium	The dry specimen breaks into pieces or crumbles with considerable finger pressure
High	The dry specimen cannot be broken with finger pressure. Specimen will break into pieces between thumb and a hard surface
Very high	The dry specimen cannot be broken between the thumb and a hard surface

TABLE 9 Criteria for Describing Dilatancy

Description	Criteria
None	No visible change in the specimen
Slow	Water appears slowly on the surface of the specimen during shaking and does not disappear or disappears slowly upon squeezing
Rapid	Water appears quickly on the surface of the specimen during shaking and disappears quickly upon squeezing

TABLE 10 Criteria for Describing Toughness

Description	Criteria
Low	Only slight pressure is required to roll the thread near the plastic limit. The thread and the lump are weak and soft
Medium	Medium pressure is required to roll the thread to near the plastic limit. The thread and the lump have medium stiffness
High	Considerable pressure is required to roll the thread to near the plastic limit. The thread and the lump have very high stiffness

the surface of the soil. Squeeze the sample by closing the hand or pinching the soil between the fingers, and note the reaction as none, slow, or rapid in accordance with the criteria in Table 9. The reaction is the speed with which water appears while shaking, and disappears while squeezing.

14.4 *Toughness:*

14.4.1 Following the completion of the dilatancy test, the test specimen is shaped into an elongated pat and rolled by hand on a smooth surface or between the palms into a thread about ⅛ in. (3 mm) in diameter. (If the sample is too wet to roll easily, it should be spread into a thin layer and allowed to lose some water by evaporation.) Fold the sample threads and reroll repeatedly until the thread crumbles at a diameter of about ⅛ in. The thread will crumble at a diameter of ⅛ in. when the soil is near the plastic limit. Note the pressure required to roll the thread near the plastic limit. Also, note the strength of the thread. After the thread crumbles, the pieces should be lumped together and kneaded until the lump crumbles. Note the toughness of the material during kneading.

14.4.2 Describe the toughness of the thread and lump as low, medium, or high in accordance with the criteria in Table 10.

14.5 *Plasticity*—On the basis of observations made during the toughness test, describe the plasticity of the material in accordance with the criteria given in Table 11.

14.6 Decide whether the soil is an *inorganic* or an *organic* fine-grained soil (see 14.8). If inorganic, follow the steps given in 14.7.

14.7 *Identification of Inorganic Fine-Grained Soils:*

TABLE 11 Criteria for Describing Plasticity

Description	Criteria
Nonplastic	A ⅛-in. (3-mm) thread cannot be rolled at any water content
Low	The thread can barely be rolled and the lump cannot be formed when drier than the plastic limit
Medium	The thread is easy to roll and not much time is required to reach the plastic limit. The thread cannot be rerolled after reaching the plastic limit. The lump crumbles when drier than the plastic limit
High	It takes considerable time rolling and kneading to reach the plastic limit. The thread can be rerolled several times after reaching the plastic limit. The lump can be formed without crumbling when drier than the plastic limit

14.7.1 Identify the soil as a *lean clay*, CL, if the soil has medium to high dry strength, no or slow dilatancy, and medium toughness and plasticity (see Table 12).

14.7.2 Identify the soil as a *fat clay*, CH, if the soil has high to very high dry strength, no dilatancy, and high toughness and plasticity (see Table 12).

14.7.3 Identify the soil as a *silt*, ML, if the soil has no to low dry strength, slow to rapid dilatancy, and low toughness and plasticity, or is nonplastic (see Table 12).

14.7.4 Identify the soil as an *elastic silt*, MH, if the soil has low to medium dry strength, no to slow dilatancy, and low to medium toughness and plasticity (see Table 12).

NOTE 11—These properties are similar to those for a lean clay. However, the silt will dry quickly on the hand and have a smooth, silky feel when dry. Some soils that would classify as MH in accordance with the criteria in Test Method D 2487 are visually difficult to distinguish from lean clays, CL. It may be necessary to perform laboratory testing for proper identification.

14.8 *Identification of Organic Fine-Grained Soils:*

14.8.1 Identify the soil as an *organic soil*, OL/OH, if the soil contains enough organic particles to influence the soil properties. Organic soils usually have a dark brown to black color and may have an organic odor. Often, organic soils will change color, for example, black to brown, when exposed to the air. Some organic soils will lighten in color significantly when air dried. Organic soils normally will not have a high toughness or plasticity. The thread for the toughness test will be spongy.

NOTE 12—In some cases, through practice and experience, it may be possible to further identify the organic soils as organic silts or organic clays, OL or OH. Correlations between the dilatancy, dry strength, toughness tests, and laboratory tests can be made to identify organic soils in certain deposits of similar materials of known geologic origin.

14.9 If the soil is estimated to have 15 to 25 % sand or gravel, or both, the words "with sand" or "with gravel" (whichever is more predominant) shall be added to the group name. For example: "lean clay with sand, CL" or "silt with gravel, ML" (see Figs. 1a and 1b). If the percentage of sand is equal to the percentage of gravel, use "with sand."

14.10 If the soil is estimated to have 30 % or more sand or gravel, or both, the words "sandy" or "gravelly" shall be added to the group name. Add the word "sandy" if there appears to be more sand than gravel. Add the word "gravelly" if there appears to be more gravel than sand. For example: "sandy lean clay, CL", "gravelly fat clay, CH", or "sandy silt, ML" (see Figs. 1a and 1b). If the percentage of sand is equal to the percent of gravel, use "sandy."

15. Procedure for Identifying Coarse-Grained Soils (Contains less than 50 % fines)

15.1 The soil is a *gravel* if the percentage of gravel is estimated to be more than the percentage of sand.

TABLE 12 Identification of Inorganic Fine-Grained Soils from Manual Tests

Soil Symbol	Dry Strength	Dilatancy	Toughness
ML	None to low	Slow to rapid	Low or thread cannot be formed
CL	Medium to high	None to slow	Medium
MH	Low to medium	None to slow	Low to medium
CH	High to very high	None	High

15.2 The soil is a *sand* if the percentage of gravel is estimated to be equal to or less than the percentage of sand.

15.3 The soil is a *clean gravel* or *clean sand* if the percentage of fines is estimated to be 5 % or less.

15.3.1 Identify the soil as a *well-graded gravel*, GW, or as a *well-graded sand*, SW, if it has a wide range of particle sizes and substantial amounts of the intermediate particle sizes.

15.3.2 Identify the soil as a *poorly graded gravel*, GP, or as a *poorly graded sand*, SP, if it consists predominantly of one size (uniformly graded), or it has a wide range of sizes with some intermediate sizes obviously missing (gap or skip graded).

15.4 The soil is either a *gravel with fines* or a *sand with fines* if the percentage of fines is estimated to be 15 % or more.

15.4.1 Identify the soil as a *clayey gravel*, GC, or a *clayey sand*, SC, if the fines are clayey as determined by the procedures in Section 14.

15.4.2 Identify the soil as a *silty gravel*, GM, or a *silty sand*, SM, if the fines are silty as determined by the procedures in Section 14.

15.5 If the soil is estimated to contain 10 % fines, give the soil a dual identification using two group symbols.

15.5.1 The first group symbol shall correspond to a clean gravel or sand (GW, GP, SW, SP) and the second symbol shall correspond to a gravel or sand with fines (GC, GM, SC, SM).

15.5.2 The group name shall correspond to the first group symbol plus the words "with clay" or "with silt" to indicate the plasticity characteristics of the fines. For example: "well-graded gravel with clay, GW-GC" or "poorly graded sand with silt, SP-SM" (see Fig. 2).

15.6 If the specimen is predominantly sand or gravel but contains an estimated 15 % or more of the other coarse-grained constituent, the words "with gravel" or "with sand" shall be added to the group name. For example: "poorly graded gravel with sand, GP" or "clayey sand with gravel, SC" (see Fig. 2).

15.7 If the field sample contains any cobbles or boulders, or both, the words "with cobbles" or "with cobbles and boulders" shall be added to the group name. For example: "silty gravel with cobbles, GM."

16. Report

16.1 The report shall include the information as to origin, and the items indicated in Table 13.

NOTE 13—*Example: Clayey Gravel with Sand and Cobbles, GC*—About 50 % fine to coarse, subrounded to subangular gravel; about 30 % fine to coarse, subrounded sand; about 20 % fines with medium plasticity, high dry strength, no dilatancy, medium toughness; weak reaction with HCl; original field sample had about 5 % (by volume) subrounded cobbles, maximum dimension, 150 mm.

In-Place Conditions—Firm, homogeneous, dry, brown

Geologic Interpretation—Alluvial fan

NOTE 14—Other examples of soil descriptions and identification are given in Appendixes X1 and X2.

NOTE 15—If desired, the percentages of gravel, sand, and fines may be stated in terms indicating a range of percentages, as follows:

Trace—Particles are present but estimated to be less than 5 %
Few—5 to 10 %
Little—15 to 25 %
Some—30 to 45 %
Mostly—50 to 100 %

16.2 If, in the soil description, the soil is identified using a classification group symbol and name as described in Test Method D 2487, it must be distinctly and clearly stated in log forms, summary tables, reports, and the like, that the symbol and name are based on visual-manual procedures.

TABLE 13 Checklist for Description of Soils

1. Group name
2. Group symbol
3. Percent of cobbles or boulders, or both (by volume)
4. Percent of gravel, sand, or fines, or all three (by dry weight)
5. Particle-size range:
   Gravel—fine, coarse
   Sand—fine, medium, coarse
6. Particle angularity: angular, subangular, subrounded, rounded
7. Particle shape: (if appropriate) flat, elongated, flat and elongated
8. Maximum particle size or dimension
9. Hardness of coarse sand and larger particles
10. Plasticity of fines: nonplastic, low, medium, high
11. Dry strength: none, low, medium, high, very high
12. Dilatancy: none, slow, rapid
13. Toughness: low, medium, high
14. Color (in moist condition)
15. Odor (mention only if organic or unusual)
16. Moisture: dry, moist, wet
17. Reaction with HCl: none, weak, strong

For intact samples:

18. Consistency (fine-grained soils only): very soft, soft, firm, hard, very hard
19. Structure: stratified, laminated, fissured, slickensided, lensed, homogeneous
20. Cementation: weak, moderate, strong
21. Local name
22. Geologic interpretation
23. Additional comments: presence of roots or root holes, presence of mica, gypsum, etc., surface coatings on coarse-grained particles, caving or sloughing of auger hole or trench sides, difficulty in augering or excavating, etc.

17. Precision and Bias

17.1 This practice provides qualitative information only, therefore, a precision and bias statement is not applicable.

18. Keywords

18.1 classification; clay; gravel; organic soils; sand; silt; soil classification; soil description; visual classification

APPENDIXES

(Nonmandatory Information)

X1. EXAMPLES OF VISUAL SOIL DESCRIPTIONS

X1.1 The following examples show how the information required in 16.1 can be reported. The information that is included in descriptions should be based on individual circumstances and need.

X1.1.1 *Well-Graded Gravel with Sand (GW)*—About 75 % fine to coarse, hard, subangular gravel; about 25 % fine to coarse, hard, subangular sand; trace of fines; maximum size, 75 mm, brown, dry; no reaction with HCl.

X1.1.2 *Silty Sand with Gravel (SM)*—About 60 % predominantly fine sand; about 25 % silty fines with low plasticity, low dry strength, rapid dilatancy, and low toughness; about 15 % fine, hard, subrounded gravel, a few gravel-size particles fractured with hammer blow; maximum size, 25 mm; no reaction with HCl (Note—Field sample size smaller than recommended).

In-Place Conditions—Firm, stratified and contains lenses of silt 1 to 2 in. (25 to 50 mm) thick, moist, brown to gray; in-place density 106 lb/ft^3; in-place moisture 9 %.

X1.1.3 *Organic Soil (OL/OH)*—About 100 % fines with low plasticity, slow dilatancy, low dry strength, and low toughness; wet, dark brown, organic odor; weak reaction with HCl.

X1.1.4 *Silty Sand with Organic Fines (SM)*—About 75 % fine to coarse, hard, subangular reddish sand; about 25 % organic and silty dark brown nonplastic fines with no dry strength and slow dilatancy; wet; maximum size, coarse sand; weak reaction with HCl.

X1.1.5 *Poorly Graded Gravel with Silt, Sand, Cobbles and Boulders (GP-GM)*—About 75 % fine to coarse, hard, subrounded to subangular gravel; about 15 % fine, hard, subrounded to subangular sand; about 10 % silty nonplastic fines; moist, brown; no reaction with HCl; original field sample had about 5 % (by volume) hard, subrounded cobbles and a trace of hard, subrounded boulders, with a maximum dimension of 18 in. (450 mm).

X2. USING THE IDENTIFICATION PROCEDURE AS A DESCRIPTIVE SYSTEM FOR SHALE, CLAYSTONE, SHELLS, SLAG, CRUSHED ROCK, AND THE LIKE

X2.1 The identification procedure may be used as a descriptive system applied to materials that exist in-situ as shale, claystone, sandstone, siltstone, mudstone, etc., but convert to soils after field or laboratory processing (crushing, slaking, and the like).

X2.2 Materials such as shells, crushed rock, slag, and the like, should be identified as such. However, the procedures used in this practice for describing the particle size and plasticity characteristics may be used in the description of the material. If desired, an identification using a group name and symbol according to this practice may be assigned to aid in describing the material.

X2.3 The group symbol(s) and group names should be placed in quotation marks or noted with some type of distinguishing symbol. See examples.

X2.4 Examples of how group names and symbols can be incororated into a descriptive system for materials that are not naturally occurring soils are as follows:

X2.4.1 *Shale Chunks*—Retrieved as 2 to 4-in. (50 to 100-mm) pieces of shale from power auger hole, dry, brown, no reaction with HCl. After slaking in water for 24 h, material identified as "Sandy Lean Clay (CL)"; about 60 % fines with medium plasticity, high dry strength, no dilatancy, and medium toughness; about 35 % fine to medium, hard sand; about 5 % gravel-size pieces of shale.

X2.4.2 *Crushed Sandstone*—Product of commercial crushing operation; "Poorly Graded Sand with Silt (SP-SM)"; about 90 % fine to medium sand; about 10 % nonplastic fines; dry, reddish-brown, strong reaction with HCl.

X2.4.3 *Broken Shells*—About 60 % gravel-size broken shells; about 30 % sand and sand-size shell pieces; about 10 % fines; "Poorly Graded Gravel with Sand (GP)."

X2.4.4 *Crushed Rock*—Processed from gravel and cobbles in Pit No. 7; "Poorly Graded Gravel (GP)"; about 90 % fine, hard, angular gravel-size particles; about 10 % coarse, hard, angular sand-size particles; dry, tan; no reaction with HCl.

X3. SUGGESTED PROCEDURE FOR USING A BORDERLINE SYMBOL FOR SOILS WITH TWO POSSIBLE IDENTIFICATIONS.

X3.1 Since this practice is based on estimates of particle size distribution and plasticity characteristics, it may be difficult to clearly identify the soil as belonging to one category. To indicate that the soil may fall into one of two possible basic groups, a borderline symbol may be used with the two symbols separated by a slash. For example: SC/CL or CL/CH.

X3.1.1 A borderline symbol may be used when the percentage of fines is estimated to be between 45 and 55 %. One symbol should be for a coarse-grained soil with fines and the other for a fine-grained soil. For example: GM/ML or CL/SC.

X3.1.2 A borderline symbol may be used when the percentage of sand and the percentage of gravel are estimated to be about the same. For example: GP/SP, SC/GC, GM/SM. It is practically impossible to have a soil that would have a borderline symbol of GW/SW.

X3.1.3 A borderline symbol may be used when the soil could be either well graded or poorly graded. For example: GW/GP, SW/SP.

X3.1.4 A borderline symbol may be used when the soil could either be a silt or a clay. For example: CL/ML, CH/MH, SC/SM.

X3.1.5 A borderline symbol may be used when a fine-grained soil has properties that indicate that it is at the boundary between a soil of low compressibility and a soil of high compressibility. For example: CL/CH, MH/ML.

X3.2 The order of the borderline symbols should reflect similarity to surrounding or adjacent soils. For example: soils in a borrow area have been identified as CH. One sample is considered to have a borderline symbol of CL and CH. To show similarity, the borderline symbol should be CH/CL.

X3.3 The group name for a soil with a borderline symbol should be the group name for the first symbol, except for:

CL/CH lean to fat clay
ML/CL clayey silt
CL/ML silty clay

X3.4 The use of a borderline symbol should not be used indiscriminately. Every effort shall be made to first place the soil into a single group.

X4. SUGGESTED PROCEDURES FOR ESTIMATING THE PERCENTAGES OF GRAVEL, SAND, AND FINES IN A SOIL SAMPLE

X4.1 *Jar Method*—The relative percentage of coarse- and fine-grained material may be estimated by thoroughly shaking a mixture of soil and water in a test tube or jar, and then allowing the mixture to settle. The coarse particles will fall to the bottom and successively finer particles will be deposited with increasing time; the sand sizes will fall out of suspension in 20 to 30 s. The relative proportions can be estimated from the relative volume of each size separate. This method should be correlated to particle-size laboratory determinations.

X4.2 *Visual Method*—Mentally visualize the gravel size particles placed in a sack (or other container) or sacks. Then, do the same with the sand size particles and the fines. Then, mentally compare the number of sacks to estimate the percentage of plus No. 4 sieve size and minus No. 4 sieve size present. The percentages of sand and fines in the minus sieve size No. 4 material can then be estimated from the wash test (X4.3).

X4.3 *Wash Test (for relative percentages of sand and fines)*—Select and moisten enough minus No. 4 sieve size material to form a 1-in (25-mm) cube of soil. Cut the cube in half, set one-half to the side, and place the other half in a small dish. Wash and decant the fines out of the material in the dish until the wash water is clear and then compare the two samples and estimate the percentage of sand and fines. Remember that the percentage is based on weight, not volume. However, the volume comparison will provide a reasonable indication of grain size percentages.

X4.3.1 While washing, it may be necessary to break down lumps of fines with the finger to get the correct percentages.

AMERICAN SOCIETY FOR TESTING AND MATERIALS
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Standard Test Method for Determining Subsurface Liquid Levels in a Borehole or Monitoring Well (Observation Well)[1]

This standard is issued under the fixed designation D 4750; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This test method describes the procedures for measuring the level of liquid in a borehole or well and determining the stabilized level of liquid in a borehole.

1.2 The test method applies to boreholes (cased or uncased) and monitoring wells (observation wells) that are vertical or sufficiently vertical so a flexible measuring device can be lowered into the hole.

1.3 Borehole liquid-level measurements obtained using this test method will not necessarily correspond to the level of the liquid in the vicinity of the borehole unless sufficient time has been allowed for the level to reach equilibrium position.

1.4 This test method generally is not applicable for the determination of pore-pressure changes due to changes in stress conditions of the earth material.

1.5 This test method is not applicable for the concurrent determination of multiple liquid levels in a borehole.

1.6 The values stated in inch-pound units are to be regarded as the standard.

1.7 *This standard may involve hazardous materials, operations, and equipment. This standard does not purport to address all of the safety problems associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Document

2.1 *ASTM Standard:*

D 653 Terminology Relating to Soil, Rock, and Contained Fluids[2]

3. Terminology

3.1 *Descriptions of Terms Specific to This Standard:*

3.1.1 *borehole*—a hole of circular cross-section made in soil or rock to ascertain the nature of the subsurface materials. Normally, a borehole is advanced using an auger, a drill, or casing with or without drilling fluid.

3.1.2 *earth material*—soil, bedrock, or fill.

3.1.3 *ground-water level*—the level of the water table surrounding a borehole or well. The ground-water level can be represented as an elevation or as a depth below the ground surface.

3.1.4 *liquid level*—the level of liquid in a borehole or well at a particular time. The liquid level can be reported as an elevation or as a depth below the top of the land surface. If the liquid is ground water it is known as water level.

3.1.5 *monitoring well* (*observation well*)—a special well drilled in a selected location for observing parameters such as liquid level or pressure changes or for collecting liquid samples. The well may be cased or uncased, but if cased the casing should have openings to allow flow of borehole liquid into or out of the casing.

3.1.6 *stabilized borehole liquid level*—the borehole liquid level which remains essentially constant with time, that is, liquid does not flow into or out of the borehole.

3.1.7 *top of borehole*—the surface of the ground surrounding the borehole.

3.1.8 *water table* (*ground-water table*)—the surface of a ground-water body at which the water pressure equals atmospheric pressure. Earth material below the ground-water table is saturated with water.

3.2 *Definitions:*

3.2.1 For definitions of other terms used in this test method, see Terminology D 653.

4. Significance and Use

4.1 In geotechnical, hydrologic, and waste-management investigations, it is frequently desirable, or required, to obtain information concerning the presence of ground water or other liquids and the depths to the ground-water table or other liquid surface. Such investigations typically include drilling of exploratory boreholes, performing aquifer tests, and possibly completion as a monitoring or observation well. The opportunity exists to record the level of liquid in such boreholes or wells, as the boreholes are being advanced and after their completion.

4.2 Conceptually, a stabilized borehole liquid level reflects the pressure of ground water or other liquid in the earth material exposed along the sides of the borehole or well. Under suitable conditions, the borehole liquid level and the ground-water, or other liquid, level will be the same, and the former can be used to determine the latter. However, when earth materials are not exposed to a borehole, such as material which is sealed off with casing or drilling mud, the borehole water levels may not accurately reflect the ground-water level. Consequently, the user is cautioned that the liquid level in a borehole does not necessarily bear a relationship to the ground-water level at the site.

4.3 The user is cautioned that there are many factors which can influence borehole liquid levels and the interpretation of borehole liquid-level measurements. These factors are not described or discussed in this test method. The

[1] This test method is under the jurisdiction of ASTM Committee D-18 on Soil and Rock and is the direct responsibility of Subcommittee D18.02 on Sampling and Related Field Testing for Soil Investigations.

Current edition approved Nov. 27, 1987. Published January 1988.

[2] *Annual Book of ASTM Standards*, Vol 04.08.

erpretation and application of borehole liquid-level information should be done by a trained specialist.

4.4 Installation of piezometers should be considered where complex ground-water conditions prevail or where changes in intergranular stress, other than those associated with fluctuation in water level, have occurred or are anticipated.

5. Apparatus

5.1 Apparatus conforming to one of the following shall be used for measuring borehole liquid levels:

5.1.1 *Weighted Measuring Tape*—A measuring tape with a weight attached to the end. The tape shall have graduations that can be read to the nearest 0.01 ft. The tape shall not stretch more than 0.05 % under normal use. Steel surveying tapes in lengths of 50, 100, 200, 300, and 500 ft (20, 30, 50 or 100 m) and widths of ¼ in. (6 mm) are commonly used. A black metal tape is better than a chromium-plated tape. Tapes are mounted on hand-cranked reels up to 500 ft (100 m) lengths. Mount a slender weight, made of lead, to the end of the tape to ensure plumbness and to permit some feel for obstructions. Attach the weight to the tape with wire strong enough to hold the weight but not as strong as the tape. This permits saving the tape in the event the weight becomes lodged in the well or borehole. The size of the weight shall be such that its displacement of water causes less than a 0.05-ft (15-mm) rise in the borehole water level, or a correction shall made for the displacement. If the weight extends beyond end of the tape, a length correction will be needed in measurement Procedure C (see 7.2.3).

5.1.2 *Electrical Measuring Device*—A cable or tape with electrical wire encased, equipped with a weighted sensing tip on one end and an electric meter at the other end. An electric circuit is completed when the tip contacts water; this is registered on the meter. The cable may be marked with graduations similar to a measuring tape (as described in 5.1.1).

5.1.3 *Other Measuring Devices*—A number of other recording and non-recording devices may be used. See Ref. **(1)** for more details.[3]

6. Calibration and Standardization

6.1 Calibrate measuring apparatus in accordance with the manufacturers' directions.

7. Procedure

7.1 Liquid-level measurements are made relative to a reference point. Establish and identify a reference point at or near the top of the borehole or a well casing. Determine and record the distance from the reference point to the top of the borehole (land surface). If the borehole liquid level is to be reported as an elevation, determine the elevation of the reference point or the top of borehole (land surface). Three alternative measurement procedures (A, B, and C) are described.

NOTE 1—In general, Procedure A allows for greater accuracy than B or C, and B allows for greater accuracy than C; other procedures have a variety of accuracies that must be determined from the referenced literature (2-5).

[3] The boldface numbers in parentheses refer to the list of references at the end of this standard.

7.2 *Procedure A—Measuring Tape:*

7.2.1 Chalk the lower few feet of tape by drawing the tape across a piece of colored carpenter's chalk.

7.2.2 Lower a weighted measuring tape slowly into the borehole or well until the liquid surface is penetrated. Observe and record the reading on the tape at the reference point. Withdraw the tape from the borehole and observe the lower end of the tape. The demarcation between the wetted and unwetted portions of the chalked tape should be apparent. Observe and record the reading on the tape at that point. The difference between the two readings is the depth from the reference point to the liquid level.

NOTE 2—Submergence of the weight and tape may temporarily cause a liquid-level rise in wells or boreholes having very small diameters. This effect can be significant if the well is in materials of very low hydraulic conductivity.

NOTE 3—Under dry surface conditions, it may be desirable to pull the tape from the well or borehole by hand, being careful not to allow it to become kinked, and reading the liquid mark before rewinding the tape onto the reel. In this way, the liquid mark on the chalked part of the tape is rapidly brought to the surface before the wetted part of the tape dries. In cold regions, rapid withdrawal of the tape from the well is necessary before the wet part freezes and becomes difficult to read. The tape must be protected if rain is falling during measurements.

NOTE 4—In some pumped wells, or in contaminated wells, a layer of oil may float on the water. If the oil layer is only a foot or less thick, read the tape at the top of the oil mark and use this reading for the water-level measurement. The measurement will not be greatly in error because the level of the oil surface in this case will differ only slightly from the level of the water surface that would be measured if no oil was present. If several feet of oil are present in the well, or if it is necessary to know the thickness of the oil layer, a water-detector paste for detecting water in oil and gasoline storage tanks is available commercially. The paste is applied to the lower end of the tape that is submerged in the well. It will show the top of the oil as a wet line and the top of the water as a distinct color change.

7.2.3 As a standard of good practice, the observer should make two measurements. If two measurements of static liquid level made within a few minutes do not agree within about 0.01 or 0.02 ft (generally regarded as the practical limit of precision) in boreholes or wells having a depth to liquid of less than a couple of hundred feet, continue to measure until the reason for the lack of agreement is determined or until the results are shown to be reliable. Where water is dripping into the hole or covering its wall, it may be impossible to get a good water mark on the chalked tape.

7.2.4 After each well measurement, in areas where polluted liquids or ground water is suspected, decontaminate that part of the tape measure that was wetted to avoid contamination of other wells.

7.3 *Procedure B—Electrical Measuring Device:*

7.3.1 Check proper operation of the instrument by inserting the tip into water and noting if the contact between the tip and the water surface is registered clearly.

NOTE 5—In pumped wells having a layer of oil floating on the water, the electric tape will not respond to the oil surface and, thus, the liquid level determined will be different than would be determined by a steel tape. The difference depends on how much oil is floating on the water. A miniature float-driven switch can be put on a two-conductor electric tape that permits detection of the surface of the uppermost fluid.

BOREHOLE OR WELL SCHEDULE FORM

Date ...., 19...... Field No. ....
Record by .... Office No. ....
Source of data ....

1. *Location:* State .... County ....
Map ....
.... ¼ .... ¼ sec. .... T .... N/S R .... E/W
2. *Owner:* .... Address ....
Tenant .... Address ....
Driller .... Address ....
3. *Topography* ....
4. *Elevation* .... ft. above/below ....
5. *Type:* Dug, drilled, driven, bored, jetted ......19....
6. *Depth:* Rept. .... ft. Meas. .... ft.
7. *Casing:* Diam. ...... in., to ...... in., Type ......
Depth .... ft., Finish ....
8. *Chief Aquifer* .... From .... ft. to .... ft.
Others ....
9. *Water level* .... ft. rept./meas. .... 19..... above/below ....
.... which is .... ft. above/below surface
10. *Pump:* Type .... Capacity .... G. M. ....
Power: Kind .... Horsepower ....
11. *Yield:* Flow .... G. M., Pump .... G. M., Meas., Rept. Est. ....
Drawdown .... ft. after .... hours pumping .... G. M.
12. *Use:* Dom., Stock, PS., RR., Ind., Irr., Obs. ....
Adequacy, permanence ....
13. *Quality* .... Temp .... °F.
Taste, odor, color .... Sample Yes/No ....
Unfit for ....
14. *Remarks:* (Log, Analyses, etc.) ....

FIG. 1 Example of a Borehole or Well Schedule Form

LIQUID LEVEL MEASUREMENT FORM

Field No. ....
Owner .... Office No. ....
Location .... Project ....
Measuring Point ....
Elevation of Measuring Point ....

Date	Hour	Depth to Water	Elev. of Water Surface	Meas. by	Remarks (Nearby wells pumping, etc.)

FIG. 2 Example of a Liquid Level Measurement Form

7.3.2 Dry the tip. Slowly lower the tip into the borehole or well until the meter indicates that the tip has contacted the surface of the liquid.

7.3.3 For devices with measurement graduations on the cable, note the reading at the reference point. This is the liquid-level depth below the reference point of the borehole or well.

7.3.4 For measuring devices without graduations on the cable, mark the cable at the reference point. Withdraw the cable from the borehole or well. Stretch out the cable and measure and record the distance between the tip and the mark on the cable by use of a tape. This distance is the liquid-level depth below the reference point.

7.3.5 A second or third check reading should be taken before withdrawing the electric tape from the borehole or well.

7.3.6 Decontaminate the submerged end of the electric tape or cable after measurements in each well.

NOTE 6—The length of the electric line should be checked by measuring with a steel tape after the line has been used for a long time or after it has been pulled hard in attempting to free the line. Some electric lines, especially the single line wire, are subject to considerable permanent stretch. In addition, because the probe is usually larger in diameter than the wire, the probe can become lodged in a well. Sometimes the probe can be attached by twisting the wires together by hand and using only enough electrical tape to support the weight of the probe. In this manner, the point of probe attachment is the weakest point of the entire line. Should the probe become "hung in the hole," the line may be pulled and breakage will occur at the probe attachment point, allowing the line to be withdrawn.

7.4 *Procedure C—Measuring Tape and Sounding Weight:*

7.4.1 Lower a weighted measuring tape into the borehole or well until the liquid surface is reached. This is indicated by an audible splash and a noticeable decrease in the downward force on the tape. Observe and note the reading on the tape at the reference point. Repeat this process until the readings are consistent to the accuracy desired. Record the result as the liquid-level depth below the reference point.

NOTE 7—The splash can be made more audible by using a "plopper," a lead weight with a concave bottom surface.

7.4.2 If the liquid level is deep, or if the measuring tape adheres to the side of the borehole, or for other reasons, it may not be possible to detect the liquid surface using this method. If so, use Procedure A or Procedure B.

8. Determination of a Stabilized Liquid Level

8.1 As liquid flows into or out of the borehole or well, the liquid level will approach, and may reach, a stabilized level. The liquid level then will remain essentially constant with time.

SITE NO

BOREHOLE OR WELL SCHEDULE FORM

Recorded by ____________ Date ____________

Check One ___ English ___ Metric Units

GENERAL SITE DATA (0)

Site Ident No ____ RG Number R • 0 • Transaction T • A D M V • (add delete modify verified)

Site-Type 2 • C D E H I M O P S T W X • Data Reliability 3 • C U • (field checked unchecked) Reporting Agency 4 •

Project No. 5 • District 6 • State 7 • County (or town) 8 •

Latitude 9 • (deg min sec) Longitude 10 • (deg min sec) Lat-Long Accuracy 11 • S F T M • (sec 5 sec 10 sec Min)

Local Number 12 • Land Net Loc 13 • S T R (1/4 1/4 1/4 section township range meridian)

Location Map 14 • Scale 15 •

Altitude 16 • Method of Measurement 17 • A L M • (altimeter level map) Accuracy 18 •

Topo Setting 19 • A B C D E F G H K L M O P S T U V W • Hydrologic Unit (OWDC) 20 •

Use of Site 23 • A C D E G H M O P R S T U W X Z • Secondary Site Use 301 • Tertiary Site Use 302

Use of Water 24 • A B C D E F H I J K M N P Q R S T U Y Z •

Secondary Water Use 25 • Tertiary Use of Water 26 • Depth of Hole 27 • Depth of Well 28 • Source of Depth Data ① 29 •

Water Level 30 • Date Measured 31 • (month day year) Source ① 33 •

Method of Measurement 34 • A B C E G H L M N R S T V Z •

Site Status 37 • D E F G H I J N O P R S T V W X Z •

Source of Geohydrologic Data ① 36 • Pump Used 35 • Date of First Construction Completion 21 • (month day year)

OWNER IDENTIFICATION (1)

R • 158 • T • A D M • (add delete modify) Date of Ownership 159 = (month day year)

Name: Last 161 = First 162 • Middle Initial 163 •

OTHER SITE IDENTIFICATION NUMBERS (1)

R • 189 • T • A D M • (add delete modify) Ident 190 = Assigner 191 •

New Card Same R & T Ident 190 = Assigner 191 •

SITE VISIT DATA (1)

R • 186 • T • A D M • (add delete modify) Date of Visit 187 = (month day year) Name of Person 188 •

FIELD WATER QUALITY MEASUREMENTS (1)

R • 192 • T • A D M • (add delete modify) Date 193 = (month day year) Geohydrologic Unit 195 =

New Card Same R thru 195

Temperature 196 = 0 0 0 1 0 • Degrees C 197 •

Conductance 196 = 0 0 0 9 5 • μ Mhos 197 •

Other (STORET) Parameter 196 = Value 197 •

Other (STORET) Parameter 196 = Value 197 •

FOOT NOTES

① Source of Data Codes

A D G L M O R S Z

FIG. 3 Example of a Borehole or Well Schedule Form

NOTE 8—The time required to reach equilibrium can be reduced by removing or adding liquid until the liquid level is close to the estimated stabilized level.

8.2 Use one of the following two procedures to determine the stabilized liquid level.

8.2.1 *Procedure 1*—Take a series of liquid-level measurements until the liquid level remains constant with time. As a minimum, two such constant readings are needed (more readings are preferred). The constant reading is the stabilized liquid level for the borehole or well.

NOTE 9—If desired, the time and level data could be plotted on graph paper in order to show when equilibrium is reached.

8.2.2 *Procedure 2*—Take at least three liquid-level measurements at approximately equal time intervals as the liquid level changes during the approach to a stabilized liquid level.

8.2.2.1 The approximate position of the stabilized liquid level in the well or borehole is calculated using the following equation:

$$h_o = \frac{y_1^2}{y_1 - y_2}$$

where:

h_o = distance the liquid level must change to reach the stabilized liquid level,

y_1 = distance the liquid level changed during the time interval between the first two liquid-level readings, and

y_2 = distance the liquid level changed during the time interval between the second and the third liquid level readings.

8.2.2.2 Repeat the above process using successive sets of three measurements until the h_o computed is consistent to the accuracy desired. Compute the stabilized liquid level in the well or borehole.

NOTE 10—The time span required between readings for Procedures 1 and 2 depends on the permeability of the earth material. In material with comparatively high permeability (such as sand), a few minutes may be sufficient. In materials with comparatively low permeability (such as clay), many hours or days may be needed. The user is cautioned that in clayey soils the liquid in the borehole or well may never reach a stabilized level equivalent to the liquid level in the earth materials surrounding the borehole or well.

9. Report

9.1 For borehole or well liquid-level measurements, report, as a minimum, the following information:

9.1.1 Borehole or well identification.

9.1.2 Description of reference point.

9.1.3 Distance between reference point and top of borehole or land surface.

9.1.4 Elevation of top of borehole or reference point (if the borehole or well liquid level is reported as an elevation).

9.1.5 Description of measuring device used, and graduation.

9.1.6 Procedure of measurement.

9.1.7 Date and time of reading.

9.1.8 Borehole or well liquid level.

9.1.9 Description of liquid in borehole or well.

9.1.10 State whether borehole is cased, uncased, or contains a monitoring (observation) well standpipe and give description of, and length below top of borehole of, casing or standpipe.

9.1.11 Drilled depth of borehole, if known.

9.2 For determination of stabilized liquid level, report:

9.2.1 All pertinent data and computations.

9.2.2 Procedure of determination.

9.2.3 The stabilized liquid level.

9.3 *Report Forms*—An example of a borehole or well-schedule form is shown in Fig. 1. An example of a liquid-level measurement form, for recording continuing measurements for a borehole or well, is shown in Fig. 2. An example of a borehole or well schedule form designed to facilitate computer data storage is shown in Fig. 3.

10. Precision and Bias

10.1 Borehole liquid levels shall be measured and recorded to the accuracy desired and consistent with the accuracy of the measuring device and procedures used. Procedure A multiple measurements by wetted tape should agree within 0.02 ft (6 mm). Procedure B multiple measurements by electrical tape should agree within 0.04 ft (12 mm). Procedure C multiple measurements by tape and sounding weight should agree within 0.04 ft (12 mm). Garber and Koopman (2) describe corrections that can be made for effects of thermal expansion of tapes or cables and of stretch due to the suspended weight of tape or cable and plumb weight when measuring liquid levels at depths greater than 500 ft (150 m).

REFERENCES

(1) "*National Handbook of Recommended Methods for Water Data Acquisition—Chapter 2—Ground Water*", Office of Water Data Coordination, Washington, DC, 1980.

(2) Garber, M. S., and Koopman, F. C., "Methods of Measuring Water Levels in Deep Wells," *U.S. Geologic Survey Techniques for Water Resources Investigations*, Book 8, Chapter A-1, 1968.

(3) Hvorslev, M. J., "Ground Water Observations," in *Subsurface Exploration and Sampling of Soils for Civil Engineering Purposes*, American Society Civil Engineers, New York, NY, 1949.

(4) Zegarra, E. J., "Suggested Method for Measuring Water Level in Boreholes," *Special Procedures for Testing Soil and Rock for Engineering Purposes, ASTM STP 479*, ASTM, 1970.

(5) "Determination of Water Level in a Borehole," CSA Standard A 119.6 - 1971, Canadian Standards Association, 1971.

APPENDIX B.2

DECONTAMINATION PROCEDURES

Equipment which comes in contact with potentially contaminated material will be cleaned after each use. The drill rig and associated sampling equipment will be decontaminated prior to use on the site, and subsequent to all sampling activities. The drill rig and associated sampling equipment will be decontaminated and surveyed for radioactive contamination prior to release from the site. The drill rig will not be released for maintenance or repair during the site activities, without decontamination and radiation survey for release. Other sampling equipment will also be surveyed for radioactive contamination prior to release from the site.

B.2.1 DRILLING AND SOIL SAMPLING EQUIPMENT

The drill rig and associated drilling and sampling equipment will be decontaminated when it arrives on site, between drilling locations, and when it is released from the site to prevent the chance of cross contamination from one location to another or release of contaminated material from the site. A centralized decontamination area will be established by Fox Drilling prior to the initiation of drilling activities. This centralized decontamination area will be capable of containing all decontamination fluids for approved disposal.

Decontamination will consist of combinations of steam cleaning, non-phosphate determent wash, water rinse, and distilled water rinse as described below. An intermediate rinse with acetone may be used.

All tools used for soil sampling and packaging, including split-barrel samplers, sample-cutting knives, etc., will be decontaminated prior to the collection of each sample. Decontamination of these tools, which may be done at the sampling site, will include a detergent wash, distilled water rinse, solvent rinse, and a second rinse with distilled water. Drying time will be allowed after rinsing.

B.2.1 WATER SAMPLING

Equipment used for well development, water level measurements, and collection of samples will be decontaminated. The decontamination of equipment for developing wells will be similar to that for sampling equipment in Section B.2.1. The electrical sounding or measuring tapes used to measure water levels will be cleaned with non-phosphate determent and rinsed with distilled water upon removal from each well, to avoid cross-contamination between wells. Solvents may be used if necessary, based on field observation.

Samples will be taken with teflon bailers which have been decontaminated prior to sampling and decontaminated between sampling locations. A new piece of nylon rope will be used as the hoisting line for each sampling location. The methods specified for drilling equipment will be used, except it may not be necessary to use a solvent rinse.

B.3 PERSONNEL DECONTAMINATION

Protective clothing will be used to minimize direct contact with the site materials. It is anticipated that field work will be conducted at Level C or D. Generally, visual indications will be an adequate measure of decontamination. However, radiation surveys will be made of personnel who have been working in waste areas, prior to their leaving the site.

- Protective clothing will be removed at the point of exit from a work area. Cleanable clothing (e,g,; gloves and boot covers) shall be rinsed at the exit from the work area and removed. Other protective clothing shall be removed at the exit from the work area and either stored for reuse or placed in designated bags for disposal.

- Cartridges from respirators shall be disposed of in indicated bags and the respirator placed in a separate bag for cleaning for reuse.

- The bags for disposal of equipment will be surveyed for airborne volatile organic materials and surveyed for radioactivity. The radiation survey will included both external gamma and a G.M. pancake probe for surface contamination.

WORK PLAN FOR CHARACTERIZATION OF RADIOACTIVE CONTAMINATION 316 EAST ILLINOIS STREET, CHICAGO, ILLINOIS

Appendix C

Health & Safety Plan

316 EAST ILLINOIS PROJECT
CHICAGO, ILLINOIS

Rogers & Associates Engineering Corporation
P.O. Box 330, Salt Lake City, Utah 84110-0330

August 27, 1993

Date 9/10/93
Approval D. Bernhardt
D.E. Bernhardt
Assistant Project Manager

RAE SITE HEALTH & SAFETY PLAN

SCOPE/OPERATIONAL BASIS: This plan is provided by Rogers and Associates Engineering Corporation (RAE), of Salt Lake City, Utah, for conducting site investigations and/or cleanup work, related to hazardous substances, as defined in OSHA regulations *29 CFR 1910.120*. The focus of RAE's field operations is to emphasize safety for RAE personnel and others, and to minimize the potential of releases of hazardous materials to the environment. The first priority is safety.

1. SITE DESCRIPTION:

Name: 316 East Illinois — Job No. C9351/2
Location: Chicago, Illinois

Approx. Size of Site: 2.6 acres

Principal Party Contact: James I. Stoller; Chicago Dock & Canal Trust

Address: 455 East Illinois Street, Suite 565, Chicago, IL 60611
Phone: (312) 467-1870

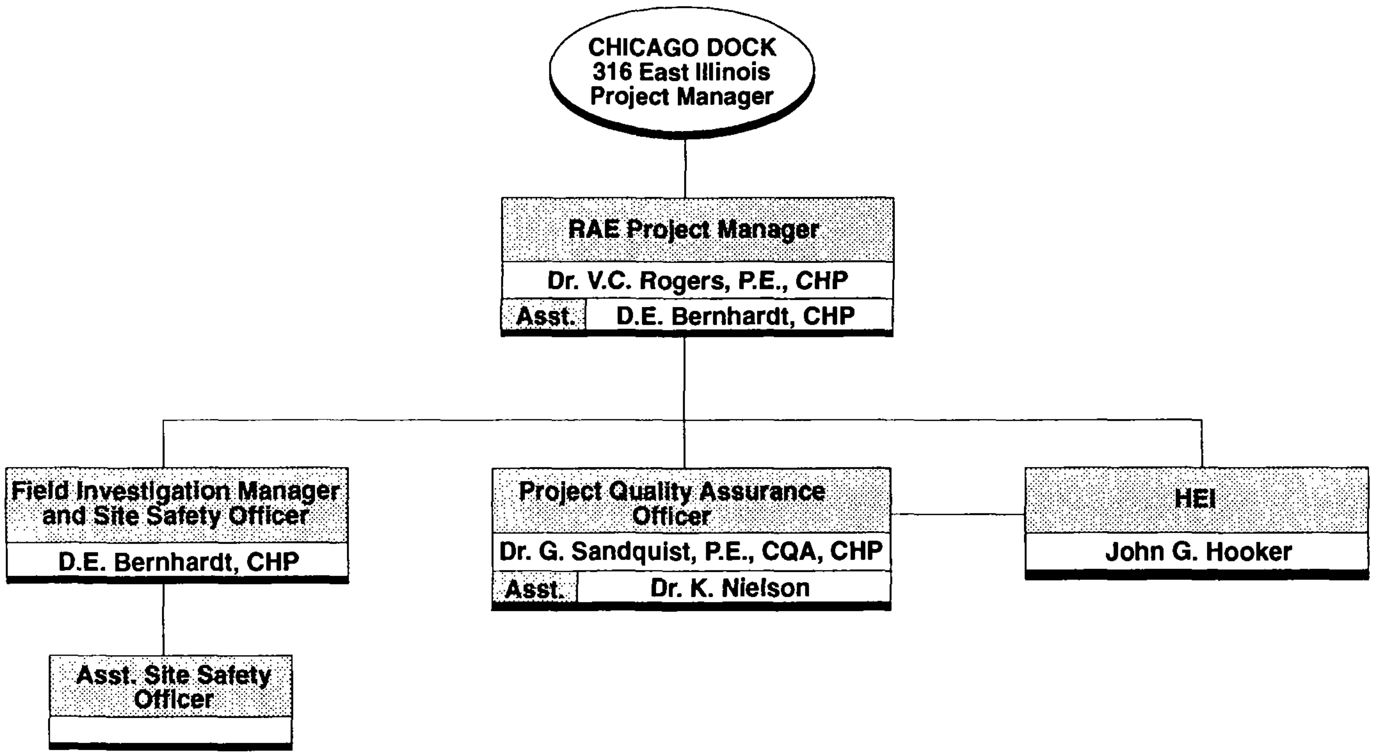
2. ENTRY OBJECTIVES:

Tasks to be performed: Drilling Borings and Soil Sampling
Existing Well Monitoring
Ambient Radiation Survey
Duration of Site Activities 2 weeks
Site Access: Motor Vehicles
Expected Weather Conditions: Work will be conducted during reasonable weather

3. SITE ORGANIZATION:

The organization of project personnel is depicted in Figure 1. The Field Investigation Manager, David E. Bernhardt, is responsible for coordinating and supervising on-site operations. He is responsible for ensuring that personnel: are aware of the provisions of this plan; are aware of the health and safety issues on the site; are instructed in proper work practices; have appropriate personal protective equipment available to them; and have been instructed in the proper use of the equipment. The Field Investigation Manager and Project Manager are Certified Health Physicists with extensive field investigation experience. The Field Investigation manager has received the Supervisor Training and 40-hour Occupational Health and Safety training.

Mr. Bernhardt is also the site Safety Officer and will: ensure proper coordination of site activities concerning health and safety; ensure that all personnel are familiar with site safety issues and the Health and Safety Plan; provide oversight to ensure that supervisors of the site activities are familiar with hazards and associated safety requirements; and ensure that necessary monitoring and measurements of conditions associated with hazards are performed (e.g., radiation monitoring and heat stress).



RAE - 105080

Figure 1. 316 East Illinois Project organization chart.

All individuals are responsible for being familiar with the Health and Safety Plan. They must be aware of the hazardous materials and conditions present on the site, including being familiar with the hazards associated with their specific work assignment. Before proceeding with their work, all individuals are responsible for knowing and implementing safe work procedures, and ensuring that they work in a safe manner.

On-site RAE Safety Officer: David E. Bernhardt

RAE Safety Coordinator:	D.E. Bernhardt	-	Home phone	801/261-1975
	V.C. Rogers	-	Home phone	801/292-8067
	K.K. Nielson	-	Home phone	801/277-7210

Federal Agency Reps: Verneta Simon; EPA On-Scene Coordinator

State Agency Reps:

Local Agency Reps:

Contractors on site: Hanson Engineers
Drilling subcontractor

Communications Available at the Site: Cellular phone

4. HAZARD EVALUATION:

The principle of maintaining exposure levels to hazardous materials As Low As Reasonably Achievable (ALARA) shall be applied to exposures to all toxic substances, both chemical toxic materials (e.g., VOCs and PNAs) and ionizing radiation.

Intrusive type sampling work has been performed on the site. The above specifications for work are based on the information from former activities and a reasonable conservative projection of work conditions. Each person shall be responsible:

- For placing the first priority on health and safety.
- For being familiar with the Health and Safety Plan.
- For performing only those tasks that they believe they can do safely.
- For reporting accidents or unsafe conditions to the Site Safety Officer.

Furthermore, the Site Safety Officer will be responsible for continual assessment of health and safety practices and for implementation of additional safety practices if prudent or necessary.

The substances, tasks, and associated hazards are summarized below.

SUBSTANCE	CONCENTRATION	HAZARDS
NORM (Th, Ra)	Present survey information ≤ 300 μR/hr	External gamma; inhalation; ingestion of dust or solids
Petroleum Hydrocarbons	Varying	Inhalation; ingestion; contact dermatitis
PNAs	> 50 ppm	Inhalation; ingestion; contact dermatitis
Ethylbenzene, Xylene	< 1 ppm	Inhalation; ingestion; contact dermatitis

MSDS Sheets attached where applicable.

TASK	ASSOCIATED HAZARDS
Drilling	Physical risks associated with drilling; exposure to NORM, Petroleum Hydrocarbons and PNAs.
Soil Sampling	Physical risks related to equipment; exposure to NORM, Petroleum Hydrocarbons and PNAs.
Well Water Sampling	Contact with water containing Petroleum Hydrocarbons or PNAs.
General Working	The potential for heat stress will be recognized, especially when working with protective clothing, such as Tyvek coveralls. See protection criteria for monitoring.

(e.g., Drilling, Well Sampling, Soil Sampling, etc.)

Utilities on Site: ____________ ____________

____________ ____________

Utilities and pipelines will be identified in proposed work areas. However, the presence of unknown pipelines shall be anticipated.

The basic criteria are for good hygienic work practices including no eating, no smoking, and no chewing within 10 meters of work areas (e.g., subsurface work). Drinking within the work area will be from single use containers filled from closed containers, unless otherwise specified. Drinking containers, such as coffee cups, will not be set down and reused.

4.1 Operational Controls, Exposure Limits

The following operational controls shall be used for work at the site. Criteria for radiation exposure rates and concentrations of chemical hazards are based on general area measurements where people are exposed, not localized areas where people would not be present for other than very short periods of time (e.g., several minutes). These controls are predicated on the principles of ALARA. The principle of ALARA shall be applied to exposures to all toxic substances, both chemically toxic materials and radiation.

The following measuring instruments will be used for sampling operations:

- **Volatile Organic Compound Detection Instruments**:
  - Hnu or Photovac MicroTip photo ionization detector instruments (PID). Instruments shall be calibrated with a span gas daily and zeroed where measurable concentrations of volatile organics do not exist.
- **Radiation Detection Instruments**:
  - TLD dosimeters for external gamma; provide integral measurement for each person.
  - External gamma radiation: Calibrated survey instruments with NaI detectors that provide results in μR/hr or other units which can be converted to μR/hr (e.g., Ludlum Model 3 or Model 2220 instruments with 1-inch NaI detector, or equivalent). Equivalent radiation instruments using G.M. or other detectors can also be used. Instruments shall be checked daily with a field check source.
  - Surface contamination shall be measured with G.M. pancake probes or equivalent detectors (thin window, sensitive to beta and alpha radiation). Instruments shall be calibrated with a traceable Cl-36, Sr-90, or other beta source, and checked daily with a field check source.

The following "operational controls" shall be used for all field investigation activities. Activities may be conducted using more limiting controls and more protective personal protective equipment (PPE) if the Site Safety Officer specifies such. The control limits are summarized in Table 1. A summary of information on the toxic materials is given in Appendix C-3.

A. **Radiation Exposure**: The following criteria reflect ranges of exposure rates, where the stated value is the lower value of the range and the value at which the specified controls will be implemented:

- **Surface Contamination**: Contamination of personnel with NORM will be minimal if any. However, all personnel who have had direct contact with NORM materials shall be monitored for surface contamination prior to leaving a general work area. Measurements should be made in a low-background area, where the background on a G.M. pancake probe is about 50 counts per minute (CPM) or less. NORM surface contamination on personnel shall be essentially background for unrestricted release and should explicitly be less than twice background. All

Table 1. Operational controls.

Operational Controls	Primary Toxic Materials		Projected Level of Control	Comment
Volatile Organics (PID 10.2 eV or higher)	Ethyl Benzene, Xylene (airborne)	10-20 ppm	Level D	Stay upwind
		>20 ppm	Level C	
		>50 ppm	Level B	
		>100 ppm	Level B	Orderly evacuation
Radiation (NORM)				
	Surface contamination	>2*Bkgd; 50 cpm net)		Don't release
	External Gamma	<400 uR/hr	Level D	No restrictions
		>400 uR/hr	Level D	Preplan work
		>500 uR/hr	Level D	Control occupancy Consider Tyvek
		>1000 uR/hr	Level D	Limited Access Require Tyvek
Heat Stress				
Body Weight		>1% loss		Monitor behavior
		>2% loss		Restrict work where PPE is needed
Oral Body Temp.		<99°F		Proceed with work
		>99°F		Revise work
		>100°F		Individual restricted in work

- Radiation monitoring will be performed.
- Heat stress will be monitored by measuring body weight changes. May also measure body temperature.

removable contamination shall be removed and the principal of ALARA applied. As a general rule, if visible dirt is not present, contamination will not be present either.

The same criteria apply to equipment. All soil sampling equipment shall be monitored before release from the site (e.g., drill rig and drilling equipment).

- All RAE and subcontractor personnel will wear TLDs (radiation dosimeters).

- **< 400 µR/hr at 1 meter above surface**: Work can be performed at Level D, unless there are other constraints. Work should be planned and work plans implemented to minimize occupancy in areas with exposure rates above 200 µR/hr. Radiation monitoring should be performed prior to and midway through work shifts. Workers leaving the area will be surveyed for surface contamination and decontamination will be performed as necessary. Protective clothing (e.g., Tyvek) is not specifically required.

- **400 µR/h**: Occupancy of the area should be minimized, radiation measurements should be taken every two hours and the need for Tyvek or equivalent coveralls to control contamination of personal clothing should be considered, but is not specifically required.

- **500 µR/hr**: Occupancy of the area will be limited by planning work. Personnel not required for the work should not be present. The use of protective clothing should be considered, but respiratory protection will generally not be required, unless there are confined spaces where radon may have accumulated or there is considerable airborne dust. Radiation measurements will be taken prior to work and at one hour intervals or more often.

- **1000 µR/hr**: Areas will be marked with brightly colored tape and special permission from the Site Safety Officer will be required for occupancy for over 60 minutes. The need for protective clothing (e.g., Tyvek and gloves) and for respiratory protection will be specifically determined by the Site Safety Officer. Work will be planned to minimize the required occupancy time and occupancy will be specifically limited to prevent unnecessary radiation exposure.

B. **Volatile Organics**: Monitoring for volatile organic airborne concentrations shall be performed using Hnu and/or MicroTip PID instruments. Field monitoring should consider both the response of a technique to benzene and also the presence of other materials and the associated response of the measurement technique. PID monitoring instruments can use different excitation lamp voltages to vary the relative response to different materials and different span gases can be used to calibrate the instruments. Isobutylene is the common span gas and the common lamp voltage is 10.6 eV for the MicroTip. A PID detector with a lamp voltage of 10.6 eV, calibrated with isobutylene, provides an overresponse of about 1.78 for benzene and 1.91 for toluene. Benzene and toluene were not detected in soil or groundwater in samples for the STS 1992 investigation and are not expected to be present.

The following controls are based on having no adverse effects from the toxic materials. However, given variations in personal susceptibility and uncertainties of monitoring, it is furthermore required:

> **If a person exhibits acute effects relatable to the subject toxic materials; such as, nausea, headaches, eye irritation**, they will leave the area. The need for a higher level of PPE will be considered by the Task Leader and the Site Safety Officer, based on the observed conditions and monitoring results.

- **<u>10-20 ppm</u>**: If monitoring results for volatile organic compounds are above 10 ppm (e.g., PID, or equivalent), monitoring will be performed continuously and workers should stay upwind of the drill hole.

- **<u>20 ppm</u>**: If monitoring results for volatile organic compounds are above 20 ppm (e.g., PID, or equivalent), work shall be performed at Level C. Cartridges shall be changed at each work break. Monitoring shall be performed continuously during work, and to the extent reasonably achievable, workers should stay upwind of the drill hole.

- **<u>20 ppm, and above</u>**: Work will be performed in Level C with air-purifying respirators with appropriate cartridges or more protective equipment. The airborne concentration of VOCs will be continuously monitored. Cartridges shall be changed at each work break. The potential of off-site airborne releases and exposures to people using the parking lots will be evaluated. Consideration will be given to revising work procedures to reduce airborne releases or terminating work.

- **<u>50 ppm VOC</u>**: Work will be performed in Level B with positive pressure demand air-supplied respirators. Monitoring for VOCs will be performed continuously and unnecessary personnel will be excluded from the area. Level B protection is sufficient for up to about 500 ppm or higher.

- **<u>100 ppm VOC</u>**: Work will be temporarily terminated at 100 ppm (general area, not just localized at drill holes).

C. Heat stress is of special concern when using protective clothing that decreases the body's ability to cool itself. Heat stress can be controlled by taking breaks, drinking adequate liquids, proper clothing, using showers to cool people, etc. If heavy continuous physical activity is required, heat stress monitoring will begin when the ambient temperature exceeds about 70° F, and specific monitoring procedures will be applied at temperatures above 80° F.

Above 80° F, with strenuous activity, breaks will be taken about every half hour. The breaks will be taken where people can cool off. Heat-stress monitoring will include measurements of the loss of body weight and possibly monitoring of the oral temperature. Close observation will be provided if weight loses exceed 1 percent. Individuals with a weight loss of over 2 percent will temporarily be removed from work requiring wearing coveralls or respirators.

If body temperatures are measured, they should be measured as early as possible after taking a break. Work conditions shall be revised to reduce heat stress if a person's oral temperature exceeds 90°F. If a person's oral temperature exceeds 100°F they will be removed from performing physical work. People exposed to extreme heat stress will be monitored and taken to a hospital if acute symptoms persist.

5. PERSONAL PROTECTION EQUIPMENT/CLOTHING (PPE) REQUIREMENTS:

Normal field clothing: Full-length pants, stout shoes, and gloves (available as needed) are required. Disposable nitrile gloves should be worn for collecting samples.

Additional PPE requirements:

-Hard hat	around drill rig or backhoe
-Safety shoes	on site
-Safety glasses	on site
-Tyvek coveralls	if > 500 μR/hr
-Breathing Protection	if VOCs > 20 ppm
-Eye Wash	Available at site
-Other (Specify)	

6. ON SITE CONTROL

Site Plan/Activity Zones: A site map is given in Figure 2. The undisturbed site exhibits low levels of contamination that is well-contained, presenting minimal concern for personnel contamination. Disturbed areas of the site, such as locations where drilling is being done, pose potential for contamination of personnel or equipment with hazardous substances. The following activity zones are denoted:

Work Zone: Work zones or work areas are denoted as the area within 5 meters of subsurface investigations. The "control" of the area will extend out to 10 meters beyond the work area, providing a total control area of a 15-meter radius around subsurface investigations.

Decontamination Zone: The need for decontamination zones is not anticipated and specific areas are not designated. There will be sufficient decontamination of equipment and personnel within the work area to prevent the spread of contamination. If necessary, decontamination zones will be designated. Final decontamination of sampling equipment will be performed at the decontamination pad. The location of the pad will be based on site conditions. No specific area on the site will be designated as a decontamination zone with a hot line.

Evacuation Gathering Point: This area will be located at least 100 ft from the site where personnel are to gather after emergency evacuation. This area should be in a predominant downwind direction from work areas if there are airborne releases. The northwest corner of the site is designates as the "Gathering Point," unless another area is specifically designated during site operations.

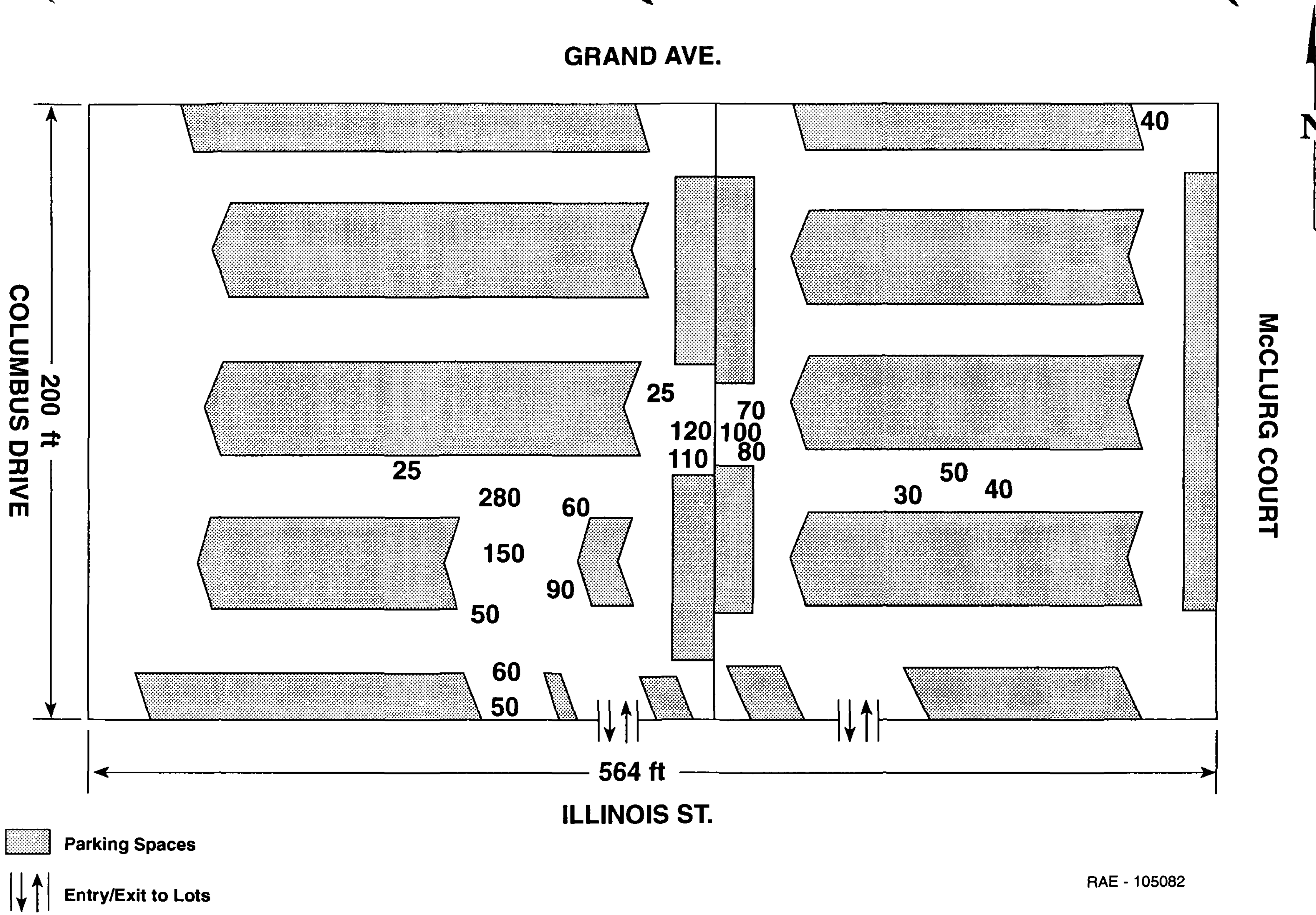


Figure 2. 316 East Illinois St. site.

7. ENVIRONMENTAL MONITORING:

The following environmental monitoring instruments will be used on site at the specified intervals (cross out if not applicable):

PID (MicroTip)	~~cont.~~	~~hourly~~	~~daily~~	other	Intermittently during activities
Radiation Meters	~~cont.~~	~~hourly~~	~~daily~~	other	Intermittently during activities
TLD	cont.	~~hourly~~	~~daily~~	~~other~~	All personnel

8. EMERGENCY RESPONSE:

Local Emergency Information (Default: Call 911)			
AGENCY	**PHONE**	**ADDRESS**	**CONTACT**
Police	911		
Fire	911		
Hospital	943-6600	333 East Huron St.	
Poison Control	800/442-2704		

SLC Medical Contact:

Name: S.L. Industrial Clinic, Holy Cross Hospital
Office Phone: (801) 973-2588
Home Phone:

Emergency Response Route: See Figure 3, west on Grand Avenue to St. Clair Street, north on St. Clair Street to Erie Street, east on Erie Street to McClurg Court, North on McClurg Court to Huron Street, West on Huron Street to the Veterans Affairs Lakeside Medical Center on 333 East Huron Street.

Emergency Procedures/Evacuation: Unless otherwise indicated below, emergency conditions, requiring evacuation are not anticipated. However, unforseen events may require evacuation. The signals for evacuation include a verbal signal and a hand signal indicating evacuation (a shout and hand signal, repeated twice, to leave), or three two second signals on a vehicle horn, repeated after a 5 second pause.

Emergency Response Plan: The following items denote the emergency response plan. Action items will be implemented prior to work on sites:

a. **Chain-of-command:** Safety Officer, and at least one, preferably two alternates, with specified authority.
D.E. Bernhardt

b. **Emergency types of conditions and required actions:** Concerns and actions for physical safety override concerns of minor spread of contamination or minor over exposure to toxic materials. However, proper response to these conditions requires planned and knowledgeable actions. For example, a person shall not remove respiratory protection in an oxygen deficient area or enter an oxygen deficient area without an SCBA to help someone else. However, such protection may be reasonably removed in intermediate radiation exposure areas if necessary to assist another person.

For example:

- Take immediate action to respond to life-threatening injuries and indications of sickness (e.g., heart attack).

- Leave areas of potential exposure immediately if there are symptoms of headache, dizziness, nausea. Seek medical attention expeditiously if these symptoms can be related to exposure to subject hazardous substances.

- Evacuate area immediately if there are indications of unknown gaseous clouds, known toxic gaseous clouds, fires, etc.

- Evacuation should be performed through the decontamination zone, unless more expedient evacuation is prudent. If people have evacuated without desired decontamination, the presence of potential contamination should be noted, and reasonable decisions made concerning providing required medical treatment or first performing decontamination.

The types of emergencies directly related to the site activities anticipated to occur are:

- **Physical and Equipment Accidents Related to the Drill Rig**: Accidents to personnel will require first aid and possibly obtaining emergency response from local 911. The route to the hospital is included as Figure 3, if a person can be transported to the hospital by site personnel.

  Potential accidents associated with the drill rig include: rupture of a fuel tank or hydraulic line, drilling into underground utilities, and hitting overhead lines with the boom. If such events occur, personnel will first be concerned with personnel safety, and then focus on containment of fluids, and recovery of the material. The priority should be on personnel safety.

- **Acute Effects From Exposure to PNAs and/or Hydrocarbons**: If there are indications of significant exposures or acute effects from exposures to toxic substances, immediate notification shall be made to 911 for emergency services. Depending on projected response times and the persons physical condition, the person shall be taken to the hospital for treatment and/or observation. Even if the acute effects do not appear to be significant, the person shall be taken to the hospital for over-night or longer observation, to ensure the availability of emergency medical services if they are required.

Plan Review by: ________________ Date: ______________________________

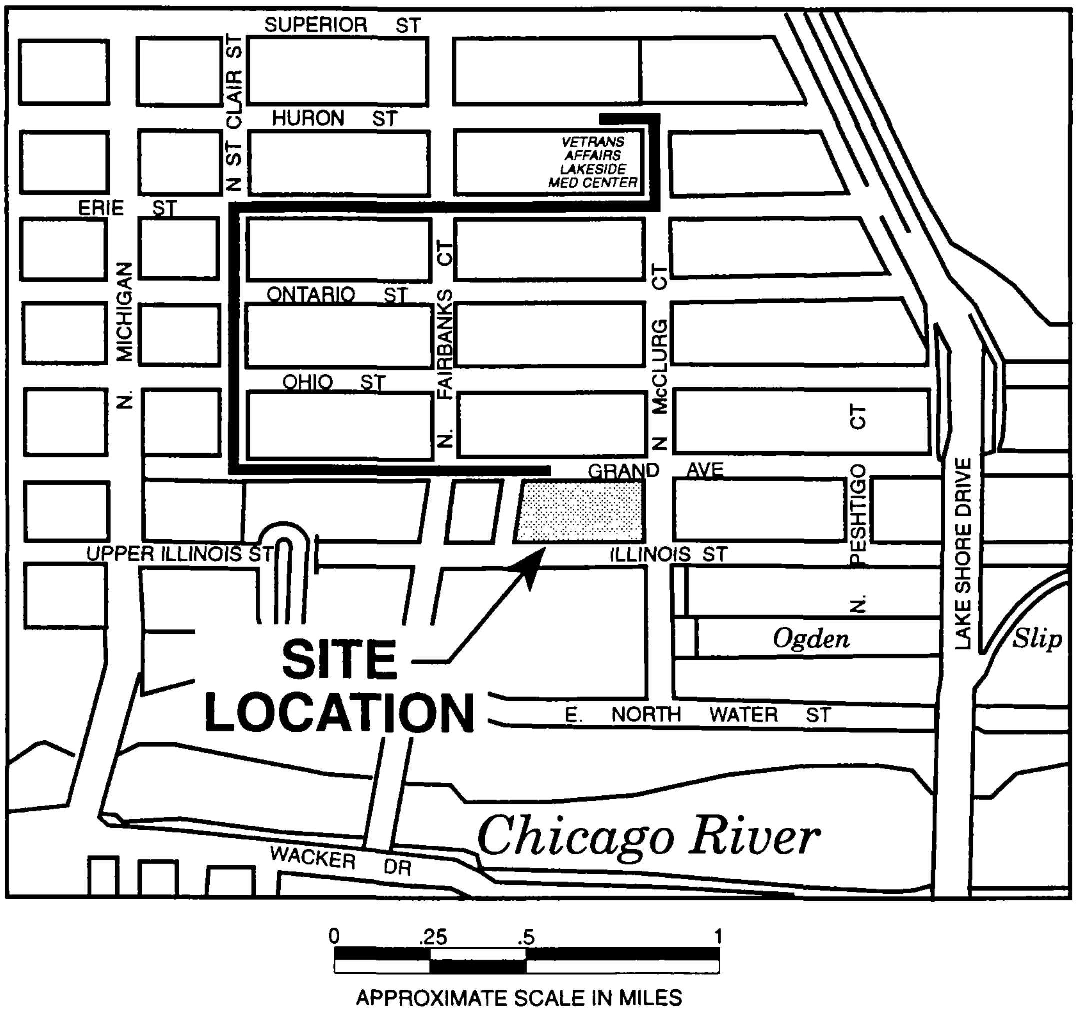


Figure 3. Directions to nearest hospital.

RAE SITE HEALTH AND SAFETY PLAN

I have read the Rogers and Associates Engineering *Site Health and Safety Plan* for work at the ____________________ site and are familiar with its provisions.

NAME: ________________________________ DATE: ______________

NAME: ________________________________ DATE: ______________

NAME: ________________________________ DATE: ______________

NAME: ________________________________ DATE: ______________

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NAME: ________________________________ DATE: ______________

APPENDIX C.1

316 EAST ILLINOIS SITE

APPENDIX C.1

316 EAST ILLINOIS SITE

1. INTRODUCTION

1.1 PROJECT DESCRIPTION AND BACKGROUND

The Chicago Dock and Canal Trust Property (Chicago Dock), at 316 E. Illinois Street, generally extends between East Illinois Street on the south to Grand Avenue on the north. It is bounded by Columbus Drive on the west and McClurg Court on the east. Figure C-1-1 is a location map, indicating the location in the state of Illinois and the City of Chicago. The U.S. Environmental Protection Agency (EPA) has measured elevated gamma radiation levels on portions of the site and has designated the site as Lindsay Light II. The site, which was leased to Lindsay Light prior to about 1933, is denoted herein as "the property." The property is presently undeveloped and has been used as a parking lot in recent years. The lot, operated by General Parking Company, is paved with asphalt and has guard rails to border the parking lot.

Chicago Dock and Canal Company was founded in 1857. Chicago Dock and Canal Trust, the direct successor, is a real estate investment trust formed in 1962. Both companies are included in the reference to "Chicago Dock," Chicago Dock records indicate that the property was leased to Lindsay Light from about 1915 to 1932. Chicago Dock records also indicate that the property from 216 to 322 East Illinois Street was rented by Cooper's Stable prior to 1913 till 1914 or later. A 2-story building on the site housed a stable for horses and wagons and a blacksmith shop.

In 1914 the Cooper Stable was divided in half, from east to west. The south half, fronting on Illinois Street at 316 E. to 322 E. was leased by Lindsay Light. Chicago Dock's records indicate that Lindsay Light made rent and tax payments on this property until about 1932. The building was demolished around 1933, which is consistent with the cessation of rent payments by Lindsay Light.

Figure C.1-1. 316 East Illinois location map.

The activities covered by this Health and Safety Plan focus on characterizing the radioactive materials that may be residuals from the Lindsay Light activities at the property. Review of property records indicates that Lindsay Light performed its primary manufacturing operations in this area of Chicago at 161 E. Grand Avenue, about one-quarter mile west of the property. The perception is that the manufacturing operations were performed at 161 E. Grand Avenue, and that the 316 E. Illinois Street site was used as a warehouse site and as a stable to provide support services for transporting material to and from the main site.

A site investigation by STS Consultants Ltd. (STS92; STS Project No. 27313-XH), July 1992, indicates that prior to the presence of Cooper's Stable and Lindsay Light, there were industrial and manufacturing activities at the property that date back to about 1900. These activities apparently included a metal polishing plant, a carbonic acid manufacturer, and a lubricating oil plant with underground storage tanks.

The STS investigation included digging several test pits, installing 4 shallow groundwater monitoring wells, and drilling numerous borings to obtain soil samples. The results of the STS investigation indicated petroleum spread over an area of approximately 24,000 square feet of the general site. The presence of petroleum appeared to be vertically centered on the water table at a depth of about 13 ft. The petroleum appeared to extend about 4 ft below and above the water table, but there was no measurable thickness of petroleum residue floating on the water table in the monitoring wells.

The following items summarize the results of the STS investigation:

- There was no radiation monitoring and samples were not analyzed for radioactivity.

- Petroleum hydrocarbons (TPH) and polynuclear aromatic hydrocarbons (PNA) were present in many samples. The detection of volatile organic compounds (e.g., xylene and/or ethylbenzene), indicates the presence of petroleum products; probably diesel, heating, or heavy lubricating oil. Benzene and toluene were not detected in the soil or water samples. The measured concentrations of total xylenes and ethylbenzene, the other constituents of BTEX, were less than 1 ppm (parts per million or mg per kg).

- Trace levels of several chlorinated solvents compounds (e.g., tetrachloroethene, trichloroethene, and tetrachloromethane) were detected in three test pit samples. However, the concentrations were at the trace level, and were not present in boring or groundwater samples. The identified concentrations were less than 1 ppm.

- No detectable levels of PCB or heavy metals were observed in the soil or groundwater samples. However, total lead and chromium concentrations in water exceeded the EPA MCLs in three of the monitoring well samples.

- The concentrations of TPH and PNAs ranged up to over 15,000 ppm.

Investigations at the site indicate that there may be residuals of radioactive material from Lindsay operations and petroleum related contaminants from prior activities. Radiation surveys performed by EPA and Illinois Department of Nuclear Safety (IDNS) on June 3, 1993, indicated radiation readings as high as 280 uR/hr on localized areas of the property, compared to a natural background for the area of about 20 uR/hr. These elevated radiation measurements may be due to residuals, containing thorium and radium, from the Lindsay Light operations.

APPENDIX C.2

316 EAST ILLINOIS PROJECT CONTACTS

APPENDIX C.2

316 EAST ILLINOIS PROJECT CONTACTS

Position	Name	Location	Phone
RAE Project Manager	Vern C. Rogers	SLC Office	801\263-1600
		Home	801\292-8067
Asst. Project Manager	David E. Bernhardt	SLC Office	801\263-1600
		Home	801\261-1975
		Cellular Ph	801\560-7365
HEI Contact	John G. Hooker	Spfld Office	217\788-2450
<u>Hospital</u>			
Veterans Affairs Lakeside Medical Center		333 East Huron St.	312/943-6600
<u>Chicago Dock Contacts</u>			
V.P. Mgt. & Development	James I. Stoller	Chicago Office	312\467-1870
President	Charles Gardner	Chicago Office	312\467-1870

APPENDIX C.3

MATERIAL PROPERTIES

APPENDIX C.3

MATERIAL PROPERTIES

This appendix provides brief summaries of health and safety information on the toxic materials present at the 316 East Illinois Site. The information on chemically toxic materials is primarily taken from I. Sax and R. Lewis, Rapid Guide to Hazardous Chemicals in the Workplace, Van Nostrand Reinhold Company, 1986 and "The NIOSH Pocket Guide to Chemical Hazards, U.S. Department of Health and Human Services, 1990. The information on the risks associated with radiation exposure is taken from the National Council on Radiation Protection and Measurements, Report No. 91, "Recommendations on Limits for Exposure to Ionizing Radiation," and the National Research Council, "Health Effects of Exposure to Low Levels of Ionizing Radiation," BEIR V, National Academy Press, 1990.

The following items describe the nature of risks and effects of exposures to the various materials:

NORM: Naturally occurring radioactive material (NORM) represents the same type of material as is present in natural rock and soil. There will be no acute health effects from exposures to the low-levels of radioactivity associated with the NORM at the site. The radiation exposures to workers will be less than the yearly exposure to natural background radiation (i.e., due to natural radioactivity in soil and cosmic radiation from space). Radiation exposures will be a fraction of the occupational regulatory limits of OSHA (29 CFR 1910), the U.S. Nuclear Regulatory Commission (10 CFR 20), and the Illinois Department of Nuclear Safety (IDNS), and will be less then the related recommendations for the general population (e.g., NCRP Report 91 and IDNS regulations).

Volatile Organic Compounds (e.g., ethyl benzene, xylene)

ETHYL BENZENE C_8H_{10}

CAS: 100-41-4	NIOSH: DA 0700000	DOT: 1175
OSHA PEL: 100 ppm	STEL: 125 ppm	IDLH: 2000 ppm

TOXIC AND HAZARD PROPERTIES:

Moderate irritation effects via irritation to the skin, eyes, mucus membranes, oral and inhalation routes. The liquid is an irritant to the skin and mucus membranes. Vapor is an irritant first to the eyes, then causes dizziness, irritation of the nose and throat and a sense of chest constriction leading to congestion of the lungs, with edema. Liquid contact can cause erythema and inflammation of the skin. Dangerous fire hazard from heat, flame, powerful oxidizers.

PROPERTIES:

Colorless liquid, aromatic odor.

MW:	106.2	VP:	(79°F)
BP:	277°F	FRZ:	-139°F
SOL:	0.01%	UEL:	6.7%
FLP:	55°F	LEL:	1.0%
IP:	8.76eV	SG:	0.87

XYLENE C_8H_{10}

CAS: 1330-20-7	NIOSH: ZE 2100000	DOT: 1307
OSHA PEL: 100 ppm	STEL: 150 ppm	IDLH:1000 ppm

TOXIC AND HAZARD PROPERTIES:

A human eye irritant; some transient corneal and conjunctival irritation effects noted. Absorbed via the skin. Dangerous fire hazard from heat, flame, powerful oxidizers.

PROPERTIES:

A clear liquid.

MW:	106.2	VP:	9
BP:	281°F	FRZ:	56°F
SOL:	Insol	UEL:	7.0%
FLP:	81°F	LEL:	1.1%
IP:	8.44eV	SG:	0.86

Ethyl Benzene or Xylene First-Aid Treatment:

If these chemicals contact the eyes, immediately wash with large amounts of water and continue flushing for 15 minutes, occasionally lifting the lower and upper lids. Get medical attention immediately. Contact lenses should not be worn when working with this chemical.

If this chemical contacts the skin, wash with soap and water.

If a person breathes large amounts of this chemical, move the exposed person to fresh air at once. If breathing has stopped, perform mouth-to-mouth resuscitation. Keep the affected person warm and at rest. Get medical attention as soon as possible.

If this chemical has been swallowed get medical attention immediately.

Polynuclear Aromatic Compounds (e.g., anthracene, fluoranthene, pyrene)

ANTHRACENE $C_{14}H_{10}$

CAS: 120-12-7 NIOSH: CA 9350000

skn-mus: 118 µg MLD scu-rat TDLo: 3300 mg/kg/33W-I:NEO

orl-rat TDLo: 20 g/kg/79W-I:ETA

TOXIC AND HAZARD REVIEW:

An experimental tumorigen and neoplastigen. A skin irritant and allergen. Combustible when exposed to heat, flame, or oxidizing materials. Moderately explosive when exposed to flame; $Ca(OCl)_2$; chromic acid. To fight fire, use water, foam, CO_2, water spray or mist, dry chemical. Explodes on contact with fluorine.

PROPERTIES:

Colorless crystals, violet fluorescence.

MW:	178.24°C	VP:	1 mm @ 145.0°C
BP:	339.9°C	FRZ:	NA
SOL:	Insol in water	UEL:	NA
FLP:	NA	LEL:	0.6%
IP:	NA	SG:	1.24 @ 27°/4°C

FLUORANTHENE $C_{16}H_{10}$

CAS: 206-44-0 NIOSH: LL 4025000

skn-mus TDLo: 280 mg/kg/58 W-I:ETA

orl-rat LD50: 2000 mg/kg

TOXIC AND HAZARD REVIEW:

Poison by intravenous route. Moderately toxic by ingestion and skin contact. An experimental tumorigen. Human mutagenic data. Combustible when exposed to heat or flame. When heated to decomposition, it emits acrid smoke and irritating fumes.

PROPERTIES:

A polycyclic hydrocarbon. Colorless solid.

MW:	202.26°C	VP:	0.01 mm @ 20°C
BP:	367°C	FRZ:	NA
SOL:	NA	UEL:	NA
FLP:	NA	LEL:	NA
IP:	NA	SG:	NA

PYRENE $C_{16}H_{10}$

CAS: 129-00-0 NIOSH: UR 2450000

skn-mus TDLo: 10 g/kg/3W-I:ETA

orl-mus LD50: 170 mg/m^3

TOXIC AND HAZARD REVIEW:

Poison by inhalation. Moderately toxic by ingestion and intraperitoneal routes. An experimental tumorigen. Human mutagenic data. A skin irritant. When heated to decomposition, it emits acrid smoke and irritating fumes.

PROPERTIES:

Colorless solid, solutions have a slight blue color.

MW:	202°C	VP:	NA
BP:	404°C	FRZ:	NA
SOL:	Insol in water	UEL:	NA
FLP:	NA	LEL:	NA
IP:	NA	SG:	1.271 @ 23°C

Heavy Petroleum Hydrocarbons

CRUDE OIL $\geq C_2H_6$; Generally C_8 and higher

CAS: 8002-05-9 NIOSH: SE 7175000

skn-mus TDLo: 3744 mg/kg/2Y-I:CAR

TOXIC AND HAZARD REVIEW:

An experimental carcinogen, neoplastigen and tumorigen by skin contact. A dangerous fire hazard when exposed to heat, flame, or powerful oxidizers. When heated to decomposition, it emits acrid smoke and irritating fumes.

PROPERTIES:

A thick flammable, dark yellow to brown or green-black liquid.

MW:	NA	VP:	NA
BP:	NA	FRZ:	NA
SOL:	Insol in water	UEL:	NA
FLP:	NA	LEL:	NA
IP:	NA	SG:	0.78-0.97

WORK PLAN FOR CHARACTERIZATION OF RADIOACTIVE CONTAMINATION 316 EAST ILLINOIS STREET, CHICAGO, ILLINOIS

Appendix D

316 East Illinois Project

QUALITY ASSURANCE PROJECT PLAN
(QAPP)

August 13, 1993

Revision ___

CONTROLLED DOCUMENT
DOCUMENT NO. ___

Approval:

**Rogers & Associates
Engineering Corporation**

Signature: ______________________
V.C. Rogers
RAE Project Manager

____
Date

Signature: ______________________
G.M. Sandquist
RAE Quality Assurance Officer

____
Date

Signature: ______________________
Chicago Dock and Canal Trust

____
Date

Signature: ______________________
(Name)
U.S. Environmental Protection Agency, Region V

____
Date

Remedial Report prepared for Remedial Investigation of 316 East Illinois, Chicago, Illinois, Site.

RAE-9351/2-1

-- D R A F T --

316 EAST ILLINOIS PROJECT

QUALITY ASSURANCE PROJECT PLAN (QAPP)

August 13, 1993

Revision ___

CONTROLLED DOCUMENT
DOCUMENT NO. ___

Approval:

Rogers & Associates Engineering Corporation

Signature: ______________________
V.C. Rogers
RAE Project Manager

____
Date

Signature: ______________________
G.M. Sandquist
RAE Quality Assurance Officer

____
Date

Signature: ______________________

Chicago Dock and Canal Trust

____
Date

Signature: ______________________
(Name)
U.S. Environmental Protection Agency, Region V

____
Date

Remedial Report prepared for Remedial Investigation of 316 East Illinois, Chicago, Illinois, Site.

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2-1 316 East Illinois Project organization chart

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1.0 IDENTIFICATION OF SITE

This information is given as the cover page for the Quality Assurance Project Plan (QAPP).

2.0 CONTENTS

The table of contents is given in the front of this QAPP. The organization is oriented to the 16 elements defined in QAMS-005/80, December 1980.

3.0 PROJECT DESCRIPTION AND BACKGROUND

The Chicago Dock and Canal Trust Property (Chicago Dock), at 316 E. Illinois Ave., generally extends between East Illinois on the south to Grand Avenue on the north. It is bounded by Columbus Ave. on the west and Mc Clurg Court on the east. Figure 3-1 shows the general layout of the site. Figure 3-2 is a location map, indicating the location in the state of Illinois and the City of Chicago. The U.S. Environmental Protection Agency (EPA) has measured elevated gamma radiation levels on portions of the site and has designated the site as Lindsay Light II. The site, which was leased to Lindsay Light prior to about 1933, is denoted herein as "the property." The property is presently undeveloped and has been used as a parking lot in recent years. The lot, operated by General Parking Company, is paved with asphalt and has guard rails to border the parking lot.

Chicago Dock and Canal Company was founded in 1857. Chicago Dock and Canal Trust, the direct successor, is a real estate investment trust formed in 1962. Both companies are included in the reference to "Chicago Dock," Chicago Dock records indicate that the property was leased to Lindsay Light from about 1915 to 1932. Chicago Dock records also indicate that the property from 216 to 322 East Illinois was rented by Cooper's Stable prior to 1913 till 1914 or later. A 2-story building on the site housed a stable for horses and wagons and a blacksmith shop.

In 1914 the Cooper Stable was divided in half, from east to west. The south half, fronting on Illinois at 316-322 was leased by Lindsay Light. Chicago Dock's records indicate that Lindsay Light made rent and tax payments on this property until about 1932. The building was demolished around 1933, which is consistent with the cessation of rent payments by Lindsay Light.

The activities covered by this QAPP focus on characterizing the radioactive materials that may be residuals from the Lindsay Light activities at the property. Review of property records indicates that Lindsay Light performed its primary manufacturing operations in this area of Chicago at 161 East Grand Ave., about one-quarter mile west of the property. The perception is that the manufacturing operations were performed at 161 East Grand Ave., and

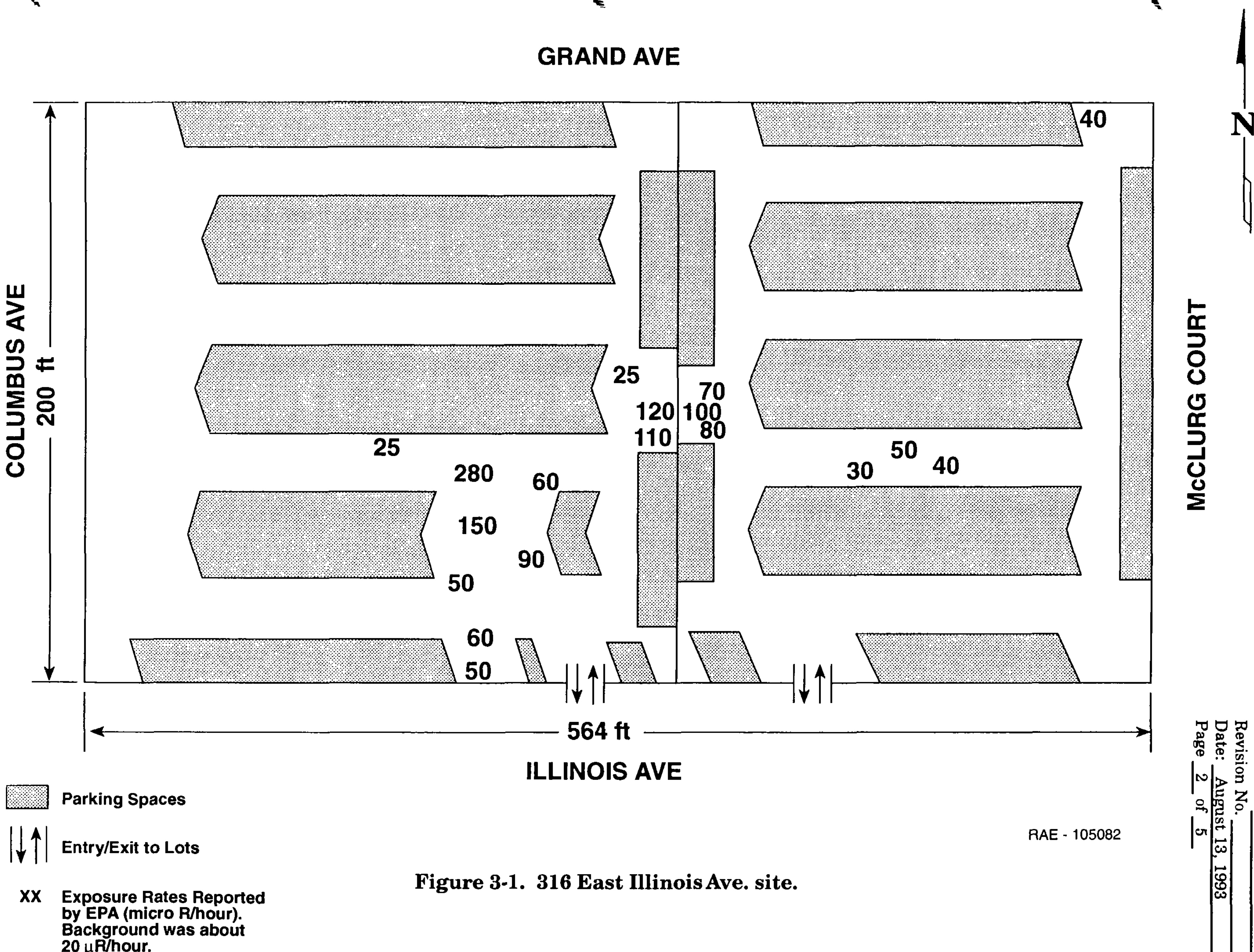


Figure 3-1. 316 East Illinois Ave. site.

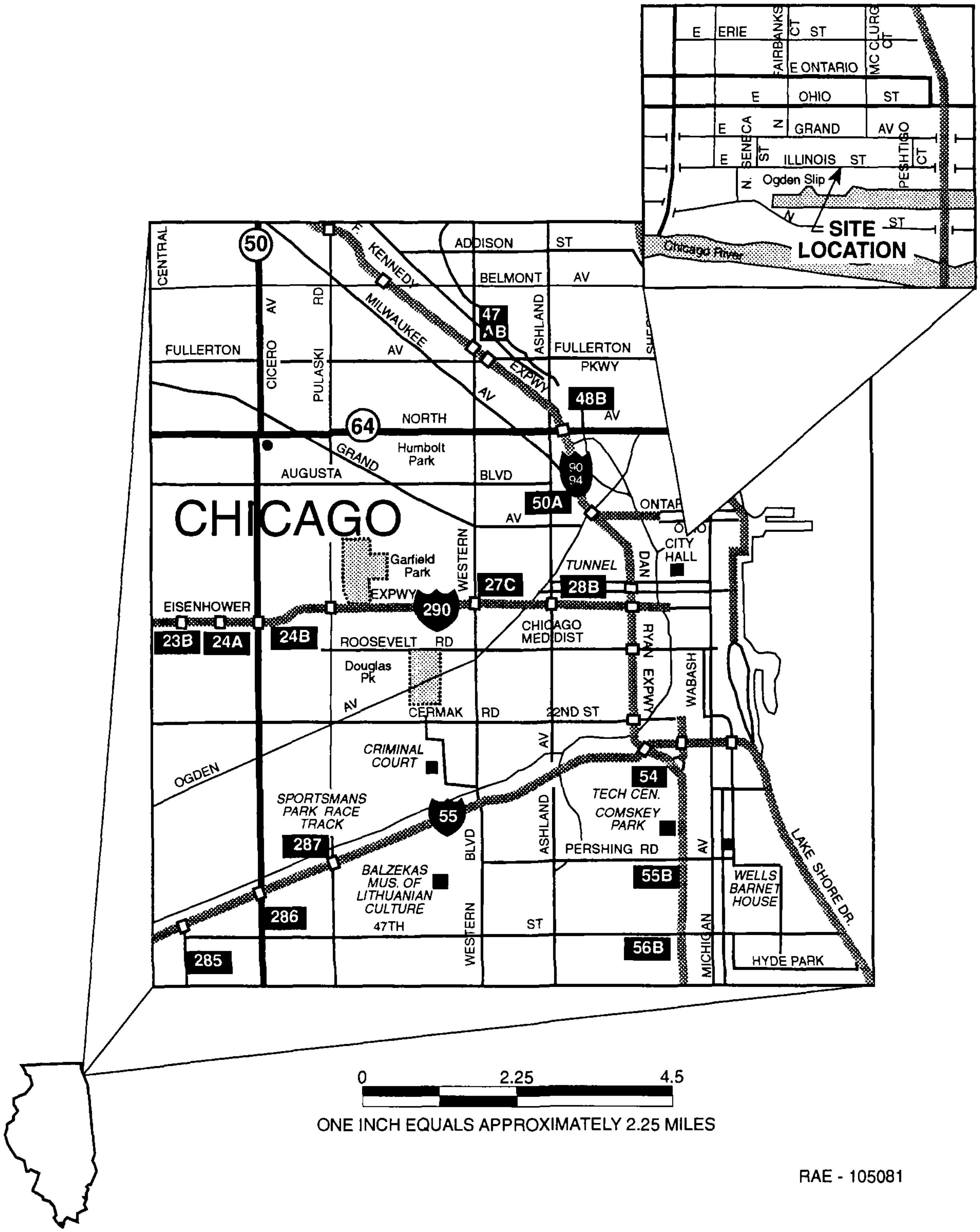


Figure 3-2. 316 East Illinois location map.

that the 316 East Illinois site was used as a warehouse site and as a stable to provide support services for transporting material to and from the main site.

A site investigation by STS Consultants Ltd. (STS92; STS Project No. 27313-XH), July 1992, indicates that prior to the presence of Cooper's Stable and Lindsay Light, there were industrial and manufacturing activities at the property that date back to about 1900. These activities apparently included a metal polishing plant, a carbonic acid manufacturer, and a lubricating oil plant with underground storage tanks.

The STS investigation included digging several test pits, installing 4 shallow groundwater monitoring wells, and drilling numerous borings to obtain soil samples. The results of the STS investigation indicated petroleum spread over an area of approximately 24,000 square feet of the general site. The presence of petroleum appeared to be vertically centered on the water table at a depth of about 13 ft. The petroleum appeared to extend about 4 ft below and above the water table, but there was no measurable thickness of petroleum residue floating on the water table in the monitoring wells.

The following items summarize the results of the STS investigation:

- Radioactive residuals (e.g., Lindsay Light): There was no radiation monitoring and samples were not specifically analyzed for radioactivity.

- Petroleum hydrocarbons (TPH) and polynuclear aromatic hydrocarbons (PNA) were present in many samples. The detection of volatile organic compounds (e.g., xylene and/or ethylbenzene), indicates the presence of petroleum products; probably diesel, heating, or heavy lubricating oil. Benzene and toluene were not detected in the soil or water samples. The measured concentrations of total xylenes and ethylbenzene, the other constituents of BTEX, were less than 1 ppm (parts per million or mg per kg).

- Trace levels of several chlorinated solvents compounds (e.g., tetrachloroethene, trichloroethene, and tetrachloromethane) were detected in three test pit samples. However, the concentrations were at the trace level, and were not present in boring or groundwater samples. The identified concentrations were less than 1 ppm.

- No detectable levels of PCB or heavy metals were observed in the soil or groundwater samples. However, total lead and chromium concentrations in water exceeded the EPA MCLs in three of the monitoring well samples.

- The concentrations of TPH and PNAs ranged up to over 15,000 ppm.

Investigations at the site indicate that there may be residuals of radioactive material from Lindsay operations and petroleum related contaminants from prior activities. Radiation surveys performed by EPA and Illinois Department of Nuclear Safety (IDNS) on June 3, 1993, indicated radiation readings as high as 280 uR/hr on localized areas of the property, compared to a natural background for the area of about 20 uR/hr. These elevated radiation measurements may be due to residuals, containing thorium and radium, from the Lindsay Light operations.

4.0 PROJECT ORGANIZATION AND RESPONSIBILITIES

RAE is providing technical and consulting services to Chicago Dock and Trust Company for the 316 East Illinois Project. Hanson Engineers Incorporated (HEI) is a subcontractor to RAE. Figure 4-1 is the 316 East Illinois Project organization chart. Lines of authority and oversight are shown along with the positions considered to be key to the proper collection and assessment of measurement data.

The key positions and their respective responsibilities to ensure the collection and analysis of valid measurement data and to ensure the proper use of analytical tools are presented in Sections 4.1 and 4.2.

Quality assurance procedures for implementation of this QAPP are referenced in the appropriate sections and are given in Appendix A. Other equivalent procedures may be used, subject to the approval of the Project Manager. The equivalence of other procedures will be based primarily on their meeting the quality assurance/quality control (QA/QC) objectives, but will also be based on providing cost-effective work.

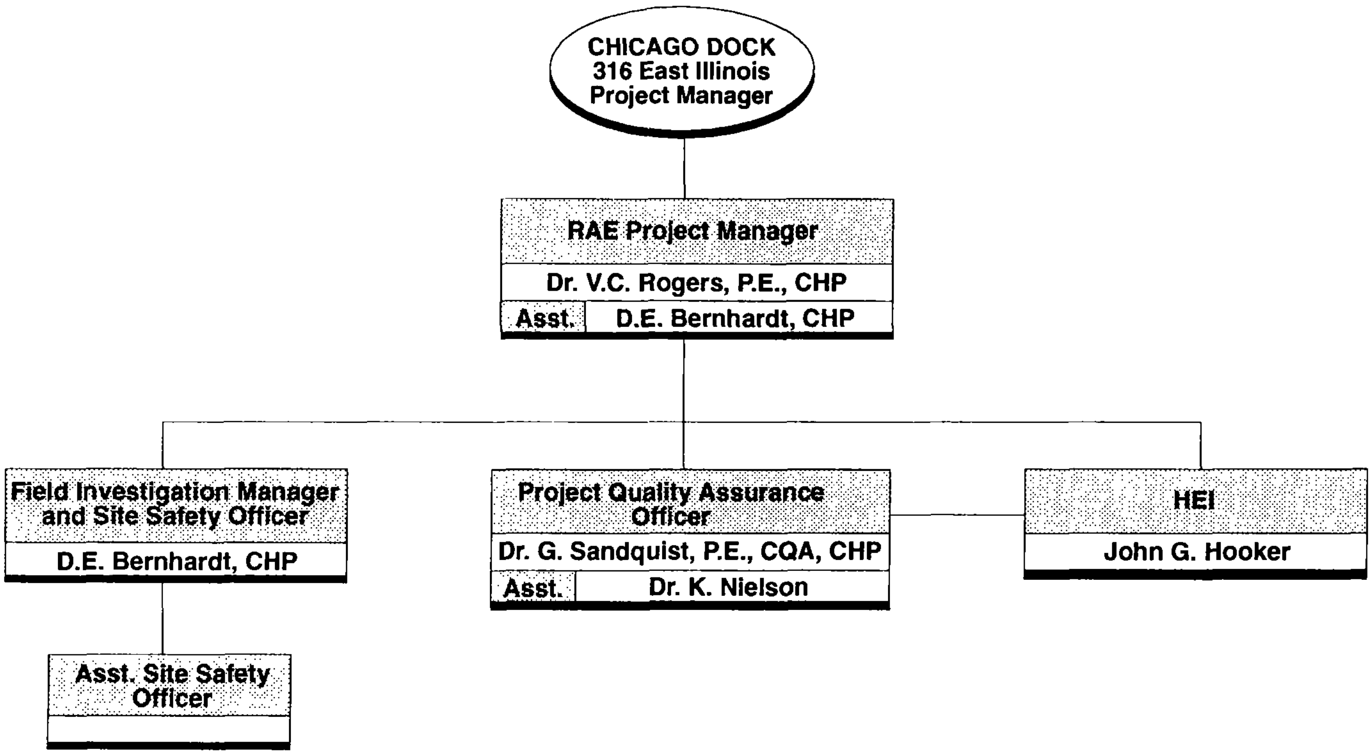
4.1 OPERATIONAL RESPONSIBILITY

Operational responsibilities are those involving execution and direct management of the technical and administrative aspects of this project. The following responsibilities and key personnel have been assigned for the 316 East Illinois Project:

- <u>Project Manager, Vern C. Rogers</u> - Responsible for overall conduct of all project work, establishes project schedules and budgets, approves the recommendations of Project QA Officer and the QA requirements for the project, and approves all controlled documents prior to their use.

- <u>Assistant Project Manager, David E. Bernhardt</u> - Supports the Project Manager in accomplishment of his responsibilities. The Assistant Project Manager is authorized to act as the Project Manager when the Project Manager is not available.

- <u>Field Investigation Manager, David E. Bernhardt</u> - Responsible to recommend to the Project Manager plans and procedures for field



RAE - 105080

Figure 4-1. 316 East Illinois Project organization chart.

investigation activities, directs and coordinates all field investigation activities, ensures that proper data collection, handling, and post analysis evaluation procedures and techniques are followed, and, in conjuction with the Project Manager, selects a Site Manager.

4.2 QUALITY ASSURANCE RESPONSIBILITY

Quality assurance (QA) responsibilities are those involved with monitoring and reviewing the procedures used to perform all aspects of this project including data collection, analytical services, and report preparation. Primary responsibility for project quality rests with the RAE Project Manager. Specific QA responsibilities for the 316 East Illinois Project have been assigned to:

- **Project QA Officer, Gary M. Sandquist** - Responsible to the President of RAE to ensure proper application of QA requirements, procedures, and practices to all 316 East Illinois Project activities; reviews, evaluates, interprets and defines the application of QA requirements, standards, and guidelines to the 316 East Illinois Project; conducts direct QA audits, surveillance, and other assurance activities; and certifies the completion of all corrective actions.

- **Assistant Project QA Officer, Kirk K. Nielson** - Responsible to the Project QA Officer to ensure the proper application of QA requirements, procedures, and practices for all 316 East Illinois Project field activities and activities performed by HEI.

- **316 East Illinois Project Laboratory Liaison, David E. Bernhardt** - Responsible for specifying the proper documentation, packaging, and handling of samples sent to project laboratories for analysis. The laboratory liaison is also responsible to the Project Manager to evaluate the sample data received from the laboratories, including evaluations for precision, accuracy, and completeness.

5.0 DATA QUALITY OBJECTIVES

Data quality is defined as the totality of features and characteristics of data that bears on its ability to satisfy a given purpose. The characteristics of importance are accuracy, precision, completeness, representativeness, and comparability. These characteristics are defined as follows:

- **Accuracy** - the degree of agreement of a measurement (or an average of measurements of the same thing), X, with an accepted reference or true value, T. It is usually expressed as the difference between the values, (X-T), or as the percentage difference with respect to the reference true value, 100 (X-T)/T. Sometimes it is expressed as the ratio, X/T. Accuracy is a measure of the bias in a system.

- **Precision** - a measure of mutual agreement among individual measurements of the same property, usually under prescribed similar conditions. Precision is best expressed in terms of the standard deviation. Various measures of precision exist, depending upon the "prescribed similar conditions."

- **Completeness** - a measure of the amount of valid data obtained from a measurement system compared to the amount that was expected to be obtained under correct normal conditions.

- **Representativeness** - an expression of the degree to which data accurately and precisely represent a characteristic of a population, parameter variations at a sampling point, a process condition, or an environmental condition.

- **Comparability** - an expression of the confidence with which one data set can be compared to another.

Data quality objectives (DQOs) shall be listed in each field investigation/sampling and analysis/work plan. DQOs will address precision, accuracy, and completeness to the degree applicable to the established measurement.

The focus of many of the measurements and sampling efforts will be to obtain information concerning specific locations, variations of constituents with depth, and other skewed or "biased" information. However, when applicable, procedures will be designed to obtain information representative of the appropriate media and location. For example, procedures for ground water sampling incorporate the purging of three well casing volumes, and measurement of pH and conductivity prior to sampling, with the intent of obtaining representative samples of the ground water.

The field activities for the 316 East Illinois Project will be met by several phases or sequences of field investigations. The objectives of the Phase I Field Investigation include obtaining information on viable DQOs for the sampling techniques and the analysis of samples for use in subsequent phases.

Many of the field measurements are based on professional judgement and/or use of field instruments and procedures that do not allow viable determination of accuracy and precision as defined for laboratory analytical procedures and results. Standard protocols and procedures and appropriate QA/QC will be applied to these investigations; e.g., geological classifications of soils, geophysical measurements, vegetation and other species identification, wetland classifications, classifications of sludge, and measurements of ionizing radiation. However, common concepts of accuracy and precision will not be appropriate. Completeness objectives will be specified where applicable.

Accuracy and precision will be addressed for field measurements, such as, pH and conductivity of water, where applicable.

The DQOs established for the 316 East Illinois Project will be based on prior experience with the sampling methods and validation techniques to be used. Such procedures and techniques have been successfully applied and accepted by regulatory agencies for remediation of sites containing the contaminants of interest at the site and/or similar environmental settings.

DQOs are considered to be approved upon approval of the appropriate field investigation/sampling and analysis/work plan by the Project Manager and the Project QA Officer.

6.0 PROCEDURES

Field and laboratory activities affecting quality are to be performed according to established procedures appropriate to the circumstances. If adequate, established procedures are not available, the basic information and requirements will be incorporated into the appropriate 316 East Illinois Project Plan to develop such procedures.

Each procedure is to specify, where applicable, the necessary equipment, environmental conditions, and methods to be used to properly perform the field or laboratory test. Calibration requirements, including frequency and standards to be used, for each applicable piece of equipment or instrument are to be clearly stated in the procedure. Procedure (P) P.1 in Appendix A provides a guide for preparation of procedures.

6.1 SAMPLING AND DATA COLLECTION PROCEDURES

Procedures for field investigation activities are contained in or included by reference in the appropriate Field Investigation Plan. The Project Manager will review, modify as necessary, approve, and recommend the Field Investigation Plans to the 316 East Illinois Project Manager.

The investigation plan for each phase of the field investigation shall include the objectives to be achieved and identify the number of sample locations, sample media, and sample analyses. Approved sampling procedures are to be included as part of the sampling plan or specifically cited as a reference. However, because a major objective of the Phase I Field Investigation is to identify the procedures for sampling the contaminated areas, latitude is provided for alternative procedures. The following information is to be provided in each Field Investigation Plan or by reference:

- A description of containers, procedures, reagents, etc., used for sample collection, preservation, and transport.
- Special conditions for the preparation of sampling equipment and containers to avoid sample contamination.

- Sample preservation methods and holding times, including time considerations for shipping samples promptly to the laboratory.
- Sample custody or chain-of-custody procedures; see Section 7.0.
- Forms, notebooks, and procedures to be used to record sample history, sampling conditions, and analyses to be performed.

6.2 SAMPLE ANALYSIS PROCEDURES

Procedures to be used to analyze environmental and investigation site samples and field measurements are to be contained in or included by reference in the respective Investigation Plans.

6.3 DATA ASSESSMENT PROCEDURES

The analytical results for samples will be evaluated for precision, accuracy, and completeness, as identified in the Field Investigation Plans. These evaluations will generally only be applicable to the analyses of samples for analytes, because there are no applicable procedures for geotechnical and other physical test procedures for soils and sludge. Given the heterogenous nature of the subject materials, assessments for precision and accuracy are not appropriate to the physical test procedures and results.

Precision of laboratory analyses will be assessed by comparing the analytical results of matrix spike/matrix spike duplicate (MS/MSD) analyses for organic analysis and laboratory duplicate analyses or matrix spikes for inorganic analysis. The relative percent difference (RPD) will be calculated for pairs of duplicate analysis or for deviations from the known value of the spiked samples.

Accuracy of laboratory results will be assessed for compliance with the established QC criteria described in the applicable Field Investigation Plan using the analytical results of method blanks, reagent/preparation blanks, MS/MSD samples, field blanks, field equipment blanks, and trip blanks.

The completeness of data resulting from laboratory analyses will be assessed for compliance with the amount of data required for decision making. Laboratory and field data will also be reviewed for completeness. Completeness reviews are the responsibility of the Task Leader for the activity which produced the measurement or the sample from which the data were obtained.

The achievement of method detection limits depends on instrumental sensitivities and matrix effects or interferences. The project contract with the analytical laboratory and oversight by the Laboratory Liaison will be used to ensure that proper procedures are employed to obtain adequate detection or quantitation limits.

The Project Manager, Field Investigation Manager, or the Task Leaders will perform daily reviews of field activities and collected information. The reviews shall confirm that proper measurements were taken, data were properly recorded, and, to the extent possible at that time of the review, that the collected data satisfy the applicable DQOs. Accuracy of the field measurements will be assessed by reviewing daily instrument calibration, check sources, repeat measurements, and analysis of blanks, as applicable. Precision will be assessed by examining the reproducibility by multiple measurements of a single sample, as applicable for the measurement.

7.0 SAMPLE CUSTODY

RAE and its subcontractors will use chain-of-custody protocols consistent with U.S. EPA Region V, sample custody protocols as described in "NEIC Policies and Procedures" (EPA-330/9-78-001-R, Revised February 1983). The chain-of-custody is in three parts: 1) sample collection, 2) laboratory, and 3) results files. Field custody (sample collection) procedures will be referenced in the Field Investigation Plans. Custody procedures for the analytical laboratories will be in accordance with each laboratory's established QA procedures.

The sample results files will be maintained as part of the project file in accordance with P.2, "Project Files."

8.0 CALIBRATION PROCEDURES AND FREQUENCY

Because many of the field investigation activities are based on instrument measurements, calibration procedures are discussed in Section 6.0. The laboratory equipment for organic and inorganic analyses will be calibrated as specified in SW-846 (EPA, PB88239223, Test Methods for Evaluating Solid Waste). Field equipment will be calibrated as specified by regulatory agency requirements or instrument manufacturers. The calibration requirements will be given in the Field Investigation Plans in the sections applicable to the measurements.

9.0 ANALYTICAL PROCEDURES

The analytical procedures are given in Section 6.0. The non-radiation measurements are taken from SW-846. Radiation measurements shall be based on procedures given in the Field Investigation Plans or standard procedures for the analytical laboratories that have been approved for the 316 East Illinois Project.

10.0 DATA REDUCTION, VALIDATION, AND REPORTING

Data from RAE laboratories, including contaminant analysis data and data on physical properties of the environment, and technical data developed by project personnel shall be reviewed by the Project Manager and Laboratory Coordinator. Accuracy, precision, and completeness requirements will be reviewed where applicable.

Data reduction, validation, and reporting for analyses conducted at non-RAE laboratories will be in accordance with each laboratory's standard practices, as accepted by RAE. The laboratories will be required to report the basic QA/QC data specified by SW-846 for the pertinent methods. All sample analysis data generated by non-RAE laboratories shall be reviewed for accuracy, precision, and completeness by the 316 East Illinois Project Laboratory Liaison or other qualified personnel as designated by the Project Manager. The data will be assessed for confirmation of compliance with QA/QC requirements by the 316 East Illinois Project Laboratory Liaison.

The laboratory deliverable packages provided by each laboratory (RAE, HEI, or outside laboratory) will be appended to applicable reports. Raw data from field measurement and sample collection activities will be documented in log books and retained as part of the project files. The use of field data and the reduction of such data used in project reports will be appropriately identified in project reports.

11.0 INTERNAL QUALITY CONTROL CHECKS

Internal quality control checks will be performed by collecting duplicate samples and field blank samples. The procedures to be used and the number of samples will be specified in the Field Investigation Plans.

12.0 PERFORMANCE AND SYSTEM AUDITS

Planned internal audits, surveillance, or checks are to be performed to provide comprehensive and independent verification and evaluation of the application of QA/QC requirements throughout the duration of the 316 East Illinois Project as performed by RAE and its subcontractors. The scope of such audit, surveillance, or check activities shall encompass: (1) evaluation of QA/QC practices and procedures and the effectiveness of their implementation, monitoring, operations, or activities; and (2) review of pertinent documents and records, and the control and maintenance of such documents and records.

Periodic surveillance of subcontractors, suppliers, and laboratories are to be performed and documented when requested by the Project Manager or when required by Chicago Dock. Surveillance results shall be reviewed by the Project Manager and other appropriate personnel. Action will be taken to correct deficiencies and document their resolutions, or proposed resolutions as per P.3, "Corrective Actions." Observed deficient areas are to be re-examined to ensure corrections have been accomplished. Immediately upon completion of and reporting on a surveillance inspection or check made by Chicago Dock, actions are to be taken and documented to correct deficiencies reported in such surveillance.

A single audit, independent of surveillance or inspection activities, shall be conducted toward the end of the activities. The audit will consist of planned and documented activities performed to determine, by investigation, examination, and evaluation of objective evidence, the adequacy of and compliance with the established procedures. It will also determine the effectiveness of implementation of the Project Plan. A single audit will be performed unless otherwise requested by Chicago Dock. Audit results shall be documented and reviewed by management personnel who have responsibility in the area audited.

The planned periodic surveillance and the audit shall be performed in accordance with P.4, "Quality Assurance Audit Procedures."

13.0 PREVENTIVE MAINTENANCE

Specific preventive maintenance procedures for sampling and field measurement equipment are referenced in or are part of the standard operating procedures applicable to the equipment. The Field Investigation Manager or his designee is responsible for implementing and documenting these procedures during the period of their use.

14.0 PROCEDURES TO ASSESS DQOs

The procedures for assessing data quality objectives are given in Section 6.0.

15.0 CORRECTIVE ACTION

Conditions adverse to quality (e.g., nonconformances, failures, malfunctions, errors, deficiencies, deviations, defective materials, etc.) shall be identified and evaluated to determine the need for corrective action in accordance with P.3, "Corrective Actions." Corrective actions are to be promptly initiated by the Project Manager when it is determined that corrective actions are needed.

Corrective actions include determination of the cause of conditions adverse to quality, the actions to prevent recurrence of those conditions, verification of acceptable completion of actions taken to resolve or rectify the conditions, and documentation of associated activities. Deficiencies and nonconformances identified through audits, surveillances, and inspections shall be reported to the Project Manager in accordance with P.3, "Corrective Actions." The cause of the nonconformance or deficiency shall be documented and actions taken for resolution. If corrective actions taken in response to nonconformance reports, audits, and surveillances are not adequately performed, the Project Manager and Project QA Officer will evaluate the conditions and determine if quality affecting activities shall be stopped in accordance with P.3, "Corrective Actions."

16.0 QUALITY ASSURANCE RECORDS AND REPORTS

The 316 East Illinois Project QA records are defined as the QAPP, its associated Procedures, standard technical procedures, and supporting and implementing documentation. Included are all changes to the QAPP and standard technical procedures, and all documentation of QA audits, surveillances, checks, and corrective actions.

Originals of all QA records for the 316 East Illinois Project are maintained by the RAE Project QA Officer or his designee. Copies are maintained as part of the project file. All project-specific QA records are retained for the duration of the project. Such records are to be transferred to Chicago Dock at the same time as the 316 East Illinois Project, project files. Any deficiencies in the project-specific QA activities will be corrected before final closeout of the project QA record is approved by the RAE QA Officer.

The 316 East Illinois Project QA records shall be stored as part of the Project File and shall be protected against damage, deterioration, vandalism, or loss. Duplicate records may be maintained at separate locations, as appropriate. Project QA records are reviewed for content and correctness in accordance with P.5, "Quality Assurance Records," and appropriate standard technical procedures and are reviewed for legibility and reproducibility prior to turnover of the project files. Reduction or transcription of original data records are completed within an interval defined by the Project Manager.

The identification, storage, and retrieval of project documents identified as QA records are in accordance with quality assurance records procedure P.5, "Project Quality Assurance Records."

316 EAST ILLINOIS PROJECT

QUALITY ASSURANCE PROJECT PLAN

APPENDIX A

QUALITY ASSURANCE PROCEDURES

TABLE OF CONTENTS

No.

P.1	Preparation of Procedures
P.2	Project Files
P.3	Corrective Actions
P.4	Quality Assurance Audit Procedures
P.5	Project Quality Assurance Records

NOTE: These procedures, or equivalent procedures approved by the 316 East Illinois Project Manager, shall be used to implement the 316 East Illinois Project QAPP.

316 EAST ILLINOIS PROJECT

QUALITY ASSURANCE PROCEDURES

P.1
Number

Preparation of Procedures
Title

Revision ___

Approval:

Technical:

Signature: ______________________

Name: D.E. Bernhardt

Title: Assistant Project Manager

Date: ______________________

Quality Assurance:

Signature: ______________________

Name: G.M. Sandquist

Title: Quality Assurance Officer

Date: ______________________

P.1 PREPARATION OF PROCEDURES

Technical and other activities affecting project quality or health and/or safety shall be conducted using approved procedures. Procedures shall be prepared for activities which are not covered by existing RAE or HEI procedures. New 316 East Illinois project specific procedures are prepared to the extent necessary according to the following format:

1.0 **Purpose**: Describe the specific purpose of the procedure.

2.0 **Applicability**: Identify the applicability of the procedure.

3.0 **Definitions**: Define words and phrases having special meaning within the procedure.

4.0 **References**: Identify pertinent literature utilized in the preparation of the procedure.

5.0 **Discussion**: If necessary, a discussion may be included to make the application or execution of the procedure more understandable.

6.0 **Responsibility**: Identify the organizational positions and responsibilities of the individuals charged with implementing the procedure.

7.0 **Equipment or Materials**: Identify equipment or materials necessary to support the procedure.

8.0 **Procedure**: Identify the specific step-by-step process to be implemented.

9.0 **Records**: List QA records and controlled documents generated as a result of the procedure.

The above subject headings are an example format and are not required to be used for all procedures.

Identification

Procedures prepared in accordance with 316 East Illinois Project QA requirements are to be dated and assigned unique letter-number designations. Each page of the procedure is to be numbered with the most current revision number.

The author who prepares procedures, addenda, or revisions to these documents shall obtain the required reviews and approvals. The 316 East Illinois Project procedures, addenda, or revisions thereto are reviewed and approved by the Project Manager or designee and the Project QA Officer or designee, as appropriate. Any revision deemed necessary shall be submitted for the same review and approval process as the original procedure.

Field revisions to procedures may be made by personnel using the procedure if following the process described above will impact project costs or schedule to a degree determined to be unacceptable by the Project Manager or his designee. In such instances, implementation personnel shall make pen and ink changes to the procedure and perform an independent check of the change. The persons making the change and the check of the change shall each initial and date the change. At the first opportunity after a field change is made, the change shall be formally documented as outlined above.

316 EAST ILLINOIS PROJECT

QUALITY ASSURANCE PROCEDURES

P.2
Number

Project Files
Title

Revision ___

Approval:

Technical:

Signature: ______________________

Name: D.E. Bernhardt

Title: Assistant Project Manager

Date: ______________________

Quality Assurance:

Signature: ______________________

Name: G.M. Sandquist

Title: Quality Assurance Officer

Date: ______________________

P.2 PROJECT FILES

The Project Manager causes project files to be maintained. The project files consist of the information necessary to document the planing, implementation, analysis, design, and quality of the activities conducted to produce the information contained in all final documents prepared for external distribution and all QA activities conducted in support of the 316 East Illinois Project. Separate technical and QA project files will be maintained.

The project file consists of an organized set of files and log sheets which allows the easy and rapid location of project information. At a minimum, the project file must contain all incoming and outgoing correspondence and copies of all internal working logs, calculation sheets, computer codes, and other project related supporting documents.

Project files are retained by RAE as directed by Chicago Dock or for a minimum of three years.

316 EAST ILLINOIS PROJECT

QUALITY ASSURANCE PROCEDURES

P.3
Number

Corrective Actions
Title

Revision ___

Approval:

Technical:

Signature: ______________________

Name: D.E. Bernhardt

Title: Assistant Project Manager

Date: ______________________

Quality Assurance:

Signature: ______________________

Name: G.M. Sandquist

Title: Quality Assurance Officer

Date: ______________________

P.3 CORRECTIVE ACTIONS

Conditions adverse to quality in equipment or in design activities, upon discovery, shall be promptly brought to the attention of the Project Manager (PM). Before proceeding further with the equipment use or design activity, the PM shall determine if corrective action is needed. If corrective action is determined to be not necessary, the PM shall include in the project files a written explanation of the nonconformity and the reasons for not taking corrective action.

If corrective action is determined to be necessary, the Project Manager shall:

- At his own discretion, determine whether to involve Chicago Dock in the selection of corrective actions.
- Ascertain the cause of the conditions adverse to quality.
- Determine appropriate corrective actions to preclude recurrence.
- Implement designated corrective actions.
- Verify that the designated corrective actions have been satisfactorily completed.
- Document all deliberations, decisions, and activities taken as corrective action.
- Notify Chicago Dock of corrective actions taken, if he judges it to be of significance to Chicago Dock.

316 EAST ILLINOIS PROJECT

QUALITY ASSURANCE PROCEDURES

P.4
Number

Quality Assurance Audits Procedures
Title

Revision ___

Approval:

Technical:

Signature: ____________________

Name: D.E. Bernhardt

Title: Assistant Project Manager

Date: ____________________

Quality Assurance:

Signature: ____________________

Name: G.M. Sandquist

Title: Quality Assurance Officer

Date: ____________________

P.4 QUALITY ASSURANCE AUDITS PROCEDURES

The Project QA Officer (designated as the QAO) or designee shall perform project-specific audits to provide comprehensive and independent verification and evaluation of the proper application of QA requirements.

Each audit shall ensure that project-specific QA requirements, as specified in the 316 East Illinois Project QAPP, are being properly applied. The date, results, and closure of each project audit shall be recorded on Form P.4-1. Form P.4-1 is used to document the actual activities performed in completing each audit.

Findings reported on Form P.4-1 are to be promptly corrected by the Project Manager or designee. The Project QA Officer is responsible to ensure that outstanding findings are corrected according to the schedule documented on Form P.4-1. The person who performed the audit verifies that the corrective action taken has resolved the intended finding. The auditor acknowledges resolution of each finding by initials and date on Form P.4-1. Audits are considered closed only after all outstanding findings are resolved to the satisfaction of the Project QA Officer. Closure of the audit is acknowledged by the Project QA Officer by signature on Form P.4-1. The original of each completed Form P.4-1 shall be retained by the Project QA Officer as part of the project QA record. A copy of each completed Form P.4-1 shall be retained by the Project Manager or designee as part of the project records.

Form P.4-1

QUALITY ASSURANCE PROGRAM

PROJECT AUDIT

1. Project Audited (Project Manager and RAE Contract) ______________________

2. Assigned Project Auditor (QAO Completes) ______________________

3. Scope and Focus of Audit (QAO Completes) ______________________

Assigned Auditor understands the purpose, scope, and focus of the audit.

Name ______________________ Date ______________

4. Applicable Documentation (Completed by Auditor)
List documents (manuals, procedures, etc.) used to implement QA requirements for this project.

RAE QAM dated ______________ QAP-1.1 dated ______________

RAE Quality Assurance Procedures and Dates (list each Procedure applicable to the project being audited).

Procedure Name or Number	Effective Date

Other Applicable Documents (list titles and effective dates)

Title	Effective Date

5. Audit Record (Completed by Auditor)

a. Project Files and Other Materials reviewed (list and date when reviewed)

b. Interviews conducted (Individuals interviewed and interview date)

c. Other Audit Activities (Specify activity conducted)

6. Audit Observations and Conclusions

7. Specific Audit Findings

		Non-Conformance		Non-Conformance Time Period	Client Data, Reports, Conclusions Affected			Corrective Action Required	
		Yes	No	____ to ____	Yes	No	Uncertain	Yes	No
a.									
b.									
c.									
d.									
e.									
f.									
g.									
h.									
i.									

8. Audit Completed by Date: __________

9. Audit Accepted by QAO ____________________ ____________________
Signature Date

10. Audit observations and findings presented and discussed with Project Manager

Date: __________ QAO Signature: ____________________

11. Planned Corrective Actions (Columns 1-3 completed by Project Manager; Column 4 completed by Auditor)

(1) Finding (Refer to Item 7)	(2) Planned Corrective Action	(3) Date Corrective Action to be Complete	(4) Corrective Action Complete Initials	(4) Corrective Action Complete Date
a				
b				
c				
d				
e				
f				
g				
h				
i				

12. Planned Corrective Actions Approved

Auditor: ____________________ Date: __________

QAO: ____________________ Date: __________

13. Audit Closure

All Corrective Actions Completed, no further action required. Audit Satisfactory.

____________________ __________
QAO Signature Date

____________________ __________
PM Signature Date

14. Date this Project Audit Form filed in Project Files ____________________

316 EAST ILLINOIS PROJECT

QUALITY ASSURANCE PROCEDURES

P.5
Number

Project Quality Assurance Records
Title

Revision ___

Approval:

Technical:

Signature: ______________________

Name: D.E. Bernhardt

Title: Assistant Project Manager

Date: ______________________

Quality Assurance:

Signature: ______________________

Name: G.M. Sandquist

Title: Quality Assurance Officer

Date: ______________________

P.5 PROJECT QUALITY ASSURANCE RECORDS

At a minimum the QA records for the 316 East Illinois Project consist of the 316 East Illinois Project QAPP, all procedures designated in the QAPP, and all required forms and records necessary to demonstrate the proper implementation of the 316 East Illinois Project QA requirements. All project QA records are maintained by the Project QA Officer as part of the Project QA file. Once a project is completed, the Project Manager shall ensure the project file is complete and obtain Project QA Officer approval of the final Project QA audit. Once the final project audit is approved by the Project QA Officer, the project file is disposed of as directed by Chicago Dock.

All project QA records are classified as non-permanent records and shall be maintained as part of the project file. Project file QA records shall be retained for three years following completion of the project or as specifically directed by Chicago Dock.

RAE-9351/2-1
Appendix E

WORK PLAN FOR CHARACTERIZATION OF RADIOACTIVE CONTAMINATION 316 EAST ILLINOIS STREET, CHICAGO, ILLINOIS

Appendix E

Supplemental Information; Other Sampling

316 EAST ILLINOIS PROJECT
CHICAGO, ILLINOIS

Rogers & Associates Engineering Corporation
P.O. Box 330, Salt Lake City, Utah 84110-0330

September 1993

APPENDIX E

This appendix provides supplemental information related to the 316 East Illinois property.

Pages E-2 to E-16 are taken from the STS 1992 investigation report (STS92). Pages E-2 - E-8 provide a summary of the sample results from the subject investigation. Pages E-10 and E-11 are two of the boring logs and pages E-12 to E-15 are the logs for the monitoring wells. Page E-9 is a map based on the U.S.G.S. quadrangle map.

September 29. 1992

Mr. Pat Newman
POWER/CRSS
8700 W. Bryn Mawr
Chicago, IL 60631

RE: Report of Environmental Investigation of the Proposed Northwestern Memorial Hospital Facility Redevelopment Site, Located between Grand, Columbus. Illinois and McClurg Court, Chicago, IL -- STS Project No. 27313-XH

Dear Mr. Newman:

STS Consultants, Ltd. has completed the environmental investigation of the above referenced site. The investigation consisted of a series of tasks including a historical and site background review. subsurface explorations and chemical testing of selected soil samples. A discussion of the exploration methods, results, analysis and recommendations are presented in this report. The results of the concurrent geotechnical exploration program are described in a separate report.

STS has appreciated the opportunity to work with POWER/CRSS on this project. If you have any questions regarding the information contained in this draft report please do not hesitate to call.

Respectfully.

STS CONSULTANTS. LTD.

David L. Grumman. Jr.
Project Geologist

Steven A. Bucher, P.E.
Associate

Richard G. Berggreen
Principal Geologist

DLG/nt/AC1

STS Consultants Ltd.
Consulting Engineers

111 Pfingsten Road
Northbrook, Illinois 60062
708.272.6520/Fax 708.498.2721

4.0 ANALYSIS AND CONCLUSIONS

General Summary of Environmental Findings

The site investigation of the proposed Northwestern Memorial Hospital Facility Development project has been completed. The site consists of three Cityfront Center parcels bounded by Grand, Columbus and Illinois Streets and a Chicago Police building. The site investigation consisted of a review of available historical information, subsurface explorations, chemical testing, and a preliminary analysis of site remediation options. The results of the historical research reveal that the site was occupied by a variety of commercial and industrial occupants in the decades preceding and following the turn of the century. Among these occupants were a lubricating oil plant, carbonic acid manufacturer, and metal polish plant, none of which appear to have remained on site past the early 1900s. During the past 50 years, the site has reverted to mostly paved vacant land used for parking.

The subsurface exploration program discovered an area of subsurface petroleum concentrations in the vicinity of the former carbonic acid and lubricating oil plants.

Based on the chemical analyses, the source of these petroleum concentrations is a petroleum product, probably a diesel, heating or lubricating oil. The location at which these petroleum concentrations were identified corresponds to the approximate position of a former lubricating oil warehouse (1905) and three underground storage tanks used by a previous carbonic acid manufacturer (1886). The highest concentrations appear to be found near the estimated former UST area. It is not known whether the USTs remain on site.

The analytical testing results suggest that, whatever the source, the petroleum concentrations are the result of historical operations, perhaps dating back to the early 1900s. The analytical results show that many of the more volatile petroleum indicator compounds (e.g. benzene, xylene, toluene, and ethylbenzene) are mostly gone. This has left the heavier, less volatile petroleum indicators, including many PNAs. The groundwater testing results showed trace to low level PNA and heavy metal detections. PNA detections can be expected from urban fill materials, as well as from petroleum product sources.

Over 20 borings, including four groundwater monitoring wells, and three test pits were performed to estimate the lateral and vertical dimensions of petroleum concentrations on site. The confines of these petroleum concentrations cover an area of approximately 24,000 square feet over a 6 to 8 foot thick area. Based on the existing testing results , the northern and southern confines of the petroleum concentrations may not be fully identified. The shallow groundwater flow direction appears to be to the south, toward the Chicago River and former Ogden Slip.

No indication of environmental impacts were observed during the subsurface exploration program from the other previously occupied areas on site or adjacent parcels. Although no indications of environmental problems in other areas on site were discovered, given the nature of the site's historical usage it is considered possible that small localized areas of contamination or sources of potential contamination such as underground storage tanks may be discovered on site during site development. It is also considered possible that the long term use of the site as a parking lot could have resulted in small and isolated areas of petroleum product contamination, none of which are likely to require remediation.

Table 2
Selected Chemical Testing Results
Results in mg/kg (parts per million)

Sample Identification

	TP1	TP2	TP3	TP4	TP6	B-108	B-109	B-115	B-118
Volatile Organic Compounds (VOC)									
acetone								16	
Benzene	--	--	--	--	--	--	--	--	--
Toluene	--	--	--	--	--	0.006	--	--	--
Ethylbenzene	--	--	--	--	--	0.086	--	0.014	--
Total Xylenes	--	--	--	--	--	0.240	0.089	0.180	0.010
Tetrachloroethene	0.044	0.036	--	--	--	--	--	--	--
Trichloroethene	0.023	--	--	--	--	--	--	--	--
Tetrachloromethane	--	--	--	0.014	--	--	--	--	--
Carbon Disulfide	--	--	--	0.014	--	--	--	--	--
Total Petroleum Hydrcarbons	NT	NT	NT	NT	NT	38	15000	37	22
Oil & Grease	NT	NT	NT	NT	NT	38	16000	43	34
Polynuclear Aromatic Hydrocarbons (PNA)									
Acenapthylene	NT	NT	NT	NT	NT	5.800	--	--	--
Acenapthene	NT	NT	NT	NT	NT	--	54.000	--	--
Fluorene	NT	NT	NT	NT	NT	18.000	--	--	--
Phenanthrene	NT	NT	NT	NT	NT	6.000	--	0.011	0.025
Anthracene	NT	NT	NT	NT	NT	21.000	7.500	0.004	0.0081
Fluoranthene	NT	NT	NT	NT	NT	38.000	25.000	--	--
Pyrene	NT	NT	NT	NT	NT	12.000	--	--	0.022
Benzo(a)anthracene	NT	NT	NT	NT	NT	1.300	0.950	--	0.0087
Chrysene	NT	NT	NT	NT	NT	1.500	0.770	--	0.021
Benzo(b)fluoranthene	NT	NT	NT	NT	NT	--	--	--	0.0066
Benzo(k)fluoranthene	NT	NT	NT	NT	NT	0.130	0.120	0.001	0.0058
Benzo(a)fluoranthene	NT	NT	NT	NT	NT	0.300	0.230	0.001	0.013
Benzo(g.h.i)perylene	NT	NT	NT	NT	NT	0.300	--	--	--

Legend:

NT: Not Tested
--: Result below laboratory practical quantitation level (PQL)

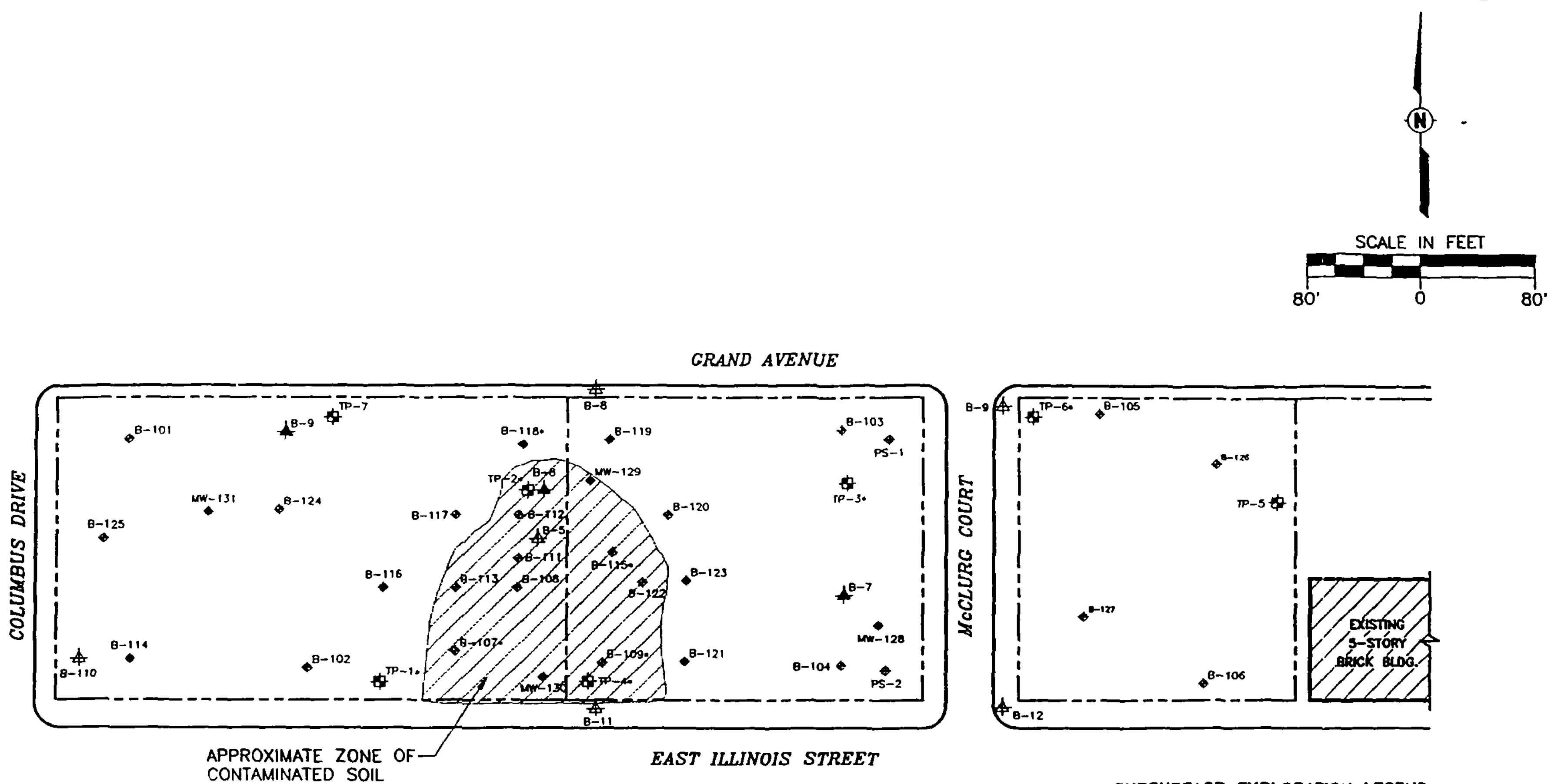
DLG/nt/AB1

Table 3
Selected Chemical Testing Results
Results in mg/kg or mg/L [water samples]

	Soil Samples					Groundwater Samples			
	B-126	B-128	B-129	B-130	B-131	MW-128	MW-129	MW-130	MW-13
Volatile Organic Compounds (VOC)*									
Benzene	NT	NT	--	NT	--	--	--	--	--
Toluene	NT	NT	--	NT	--	--	--	0.13	--
Ethylbenzene	NT	NT	--	NT	--	--	--	--	--
Total Xylenes	NT	NT	--	NT	--	--	--	0.13	--
Tetrachloroethene	NT	NT	--	NT	--	--	--	--	--
Trichloroethene	NT	NT	--	NT	--	--	--	--	--
Tetrachloromethane	--	--	--	0.014	--	--	--	--	--
Carbon Disulfide	--	--	--	0.014	--	--	--	--	--
RCRA Heavy Metals*									
Barium	1.0	12.1	0.2	1.1	0.1	0.33	0.21	0.29	0.14
Lead	--	--	--	--	--	0.50	--	1.80	2.90
Chromium	--	--	--	--	--	--	--	0.06	--
Polynuclear Aromatic Hydrocarbons (PNA)									
Acenapthylene	NT	NT	NT	NT	NT	--	--	--	--
Acenapthene	NT	NT	NT	NT	NT	--	--	--	--
Fluorene	NT	NT	NT	NT	NT	--	--	--	--
Phenanthrene	NT	NT	NT	NT	NT	--	--	--	--
Anthracene	NT	NT	NT	NT	NT	--	--	0.087	--
Fluoranthene	NT	NT	NT	NT	NT	0.0021	--	--	--
Pyrene	NT	NT	NT	NT	NT	--	--	--	--
Benzo(a)anthracene	NT	NT	NT	NT	NT	0.00095	--	--	0.0001
Benzo(a)pyrene	NT	NT	NT	NT	NT	0.00097	--	--	0.0002
Chrysene	NT	NT	NT	NT	NT	--	--	--	--
Benzo(b)fluoranthene	NT	NT	NT	NT	NT	--	--	--	--
Benzo(k)fluoranthene	NT	NT	NT	NT	NT	--	--	--	--
Benzo(a)fluoranthene	NT	NT	NT	NT	NT	--	--	--	--
Benzo(g,h,i)perylene	NT	NT	NT	NT	NT	--	--	--	--
Napthalene	NT	NT	NT	NT	NT	--	--	0.37	--

Legend:
NT: Not Tested
--: Result below laboratory practical quantitation level (PQL)
* : Only compounds detected are listed

DLG/nt/AB1



SUBSURFACE EXPLORATION LEGEND

- BORINGS STS JOB #27313 (1992)
- BORINGS STS JOB #27313XH (1992) (MW PREFIX INDICATES MONITORING WELL INSTALLATION)
- TEST PITS STS JOB #27313XH (1992)
- BORINGS STS JOB #25400XF (1988)
- BORINGS STS JOB #24418-N (1987)
- BORINGS STS JOB #24418-C (1986)
- * SAMPLE RETAINED FOR CHEMICAL TESTING

DRAWN BY PCK	DATE 8/6/92	
CHECKED BY DLG	DATE 8/6/92	
APPROVED BY SAB	DATE 8/6/92	
CADFILE: D:\PEOPLE\KRESK\DWG\DEPT3\27313.dwg		

EXTENT OF CONTAMINATION DIAGRAM
PROPOSED NORTHWESTERN MEMORIAL HOSPITAL
GRAND/COLUMBUS/ILLINOIS/McCLURG COURT
CHICAGO, ILLINOIS

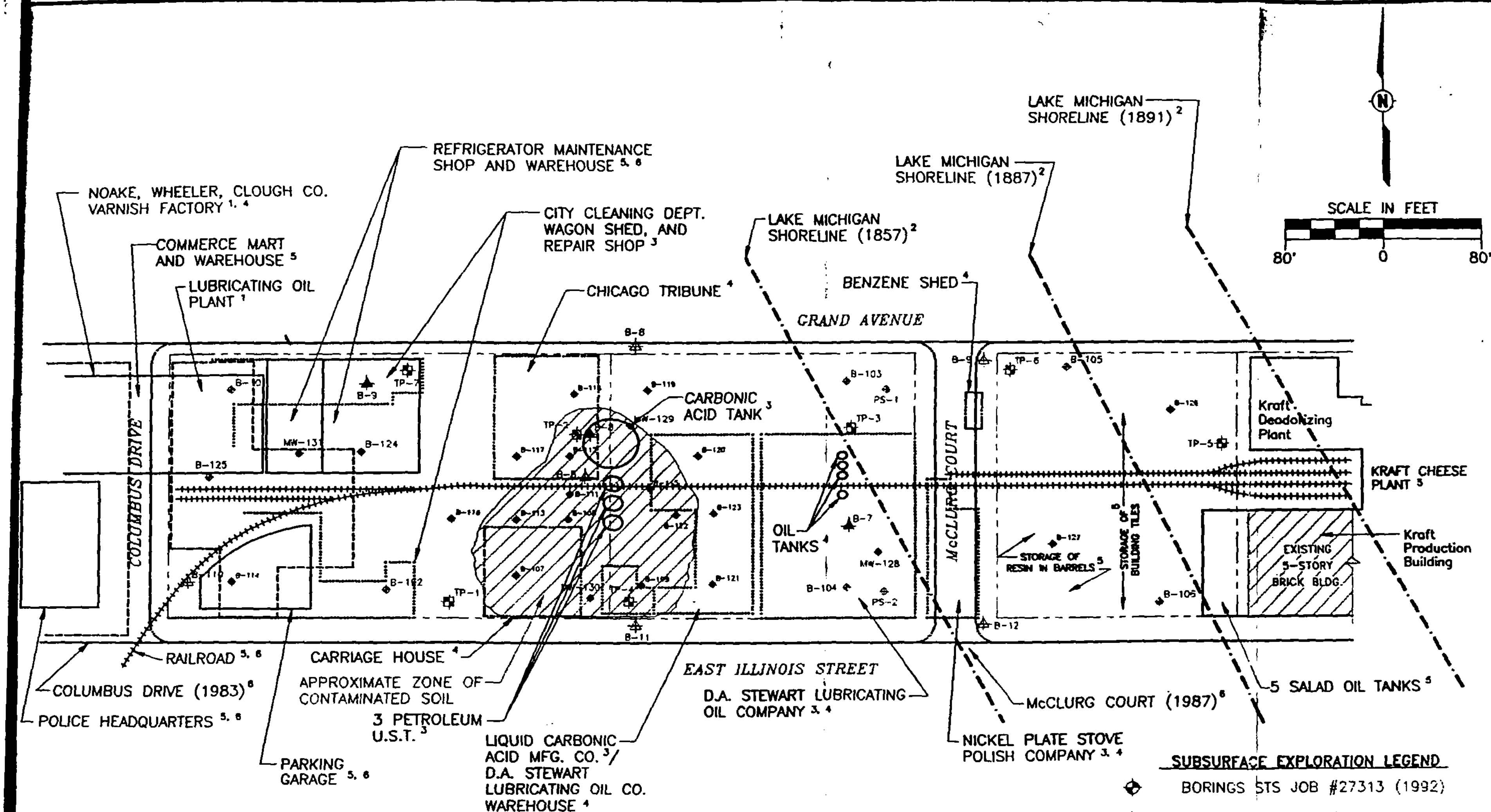
STS CONSULTANTS Ltd.
CONSULTING ENGINEERS

STS PROJECT NO. 27313-XH

STS PROJECT FILE

SCALE: 1" = 80'±

SHEET NO. FIGURE 3



HISTORICAL REFERENCES

1. ROBINSONS ATLAS OF CHICAGO, FIRE INSURANCE MAP (1886) [-----------]
2. GREELY CARLSON FIRE INSURANCE MAP (1891) [— - — — - —]
3. RASCHER FIRE INSURANCE MAP (1891) [..............]
4. SANBORN FIRE INSURANCE MAP (1905) [-..-..-..-]
5. SANBORN FIRE INSURANCE MAP (1949) [————]
6. AERIAL PHOTOGRAPHY OF SITE, MISC. YEARS 1938–1988

THE LOCATIONS OF THE HISTORICAL STRUCTURES AS ILLUSTRATED ABOVE ARE CONSIDERED APPROXIMATE AND ARE BASED ON THE REFERENCES LISTED.

SUBSURFACE EXPLORATION LEGEND

- BORINGS STS JOB #27313 (1992)
- BORINGS STS JOB #27313XH (1992) (MW PREFIX INDICATES MONITORING WELL INSTALLATION)
- TEST PITS STS JOB #27313XH (1992)
- BORINGS STS JOB #25400XF (1988)
- BORINGS STS JOB #24418-N (1987)
- BORINGS STS JOB #24418-C (1986)

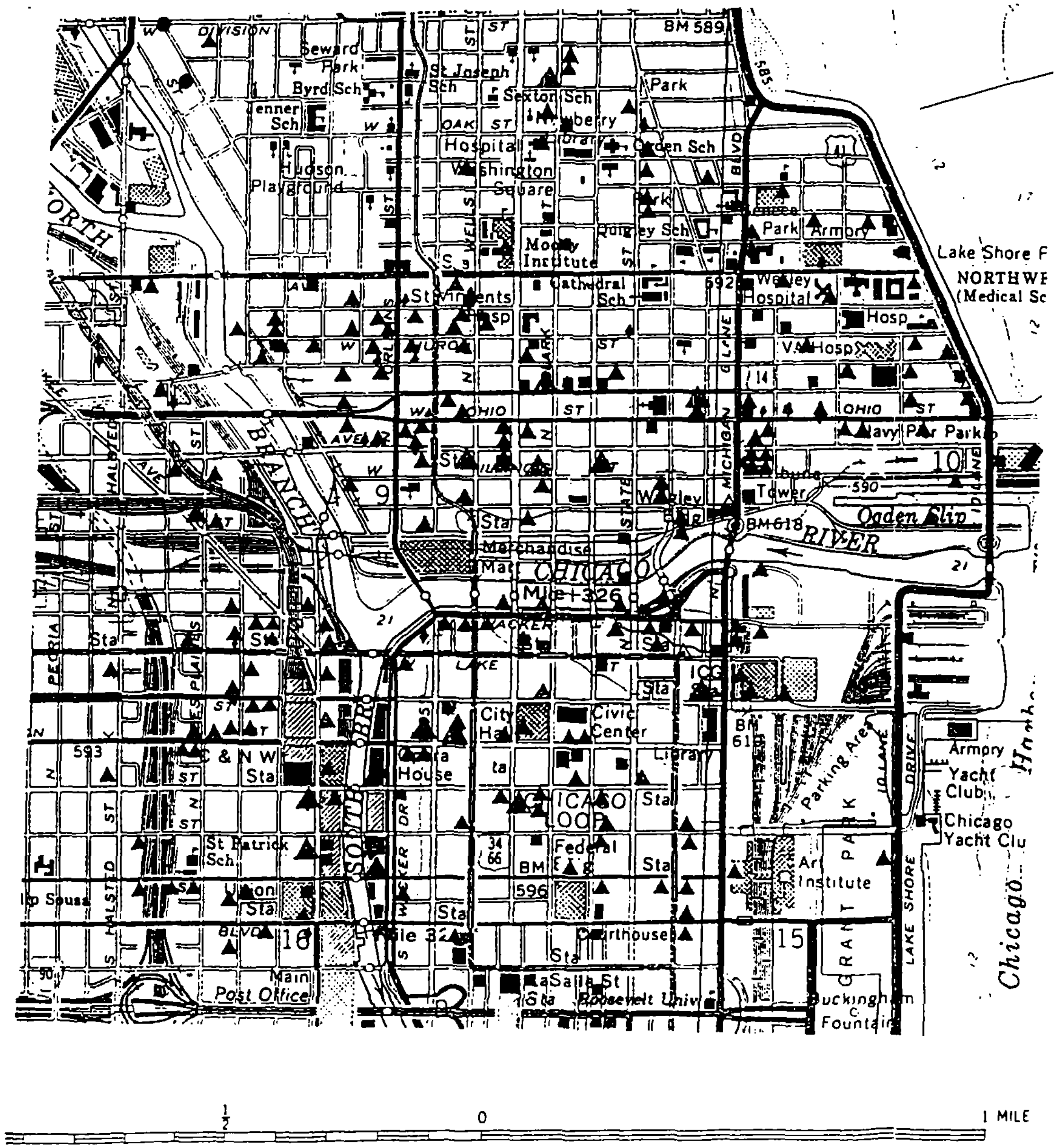
DRAWN BY PCK	DATE 8/6/92	
CHECKED BY DLG	DATE 8/6/92	
APPROVED BY SAB	DATE 8/6/92	
CADFILE: D:\PEOPLE\KRESKI\DWG\DEPT5\27313.dwg		

HISTORICAL SITE USAGE DIAGRAM
PROPOSED NORTHWESTERN MEMORIAL HOSPITAL
GRAND/COLUMBUS/ILLINOIS/McCLURG COURT
CHICAGO, ILLINOIS

STS CONSULTANTS LTD. CONSULTING ENGINEERS

STS PROJECT NO. 27313-XH
STS PROJECT FILE
SCALE: 1" = 80'±
SHEET NO. FIGURE 5

F-8



REF. BASE MAP: USGS QUADRANGLE MAP
7.5 MINUTE SERIES (TOPOGRAPHIC)
CHICAGO LOOP
PHOTOREVISED 1972

N

LEGEND

SITE

- ● CERCLIS SITES
- ▲ RCRA GENERATORS AND TSDS FACILITIES [1]
- ■ UST SITES [2]
- ♦ LUST SITES [3]
- SOLID WASTE DISPOSAL SITES [4]

LEGEND

1. USEPA COMPUTER DATA BASE SEARCH DATED 5-21-91.
2. ILLINOIS STATE FIRE MARSHALL UNDERGROUND STORAGE TANKS (UST) DATA BASE 6-2-90.
3. ILLINOIS STATE FIRE MARSHALL LIST OF LEAKING UNDERGROUND STORAGE TANKS (LUST) INCIDENTS REPORT 5-1-91
4. NORTHEASTERN ILLINOIS PLANNING COMMISSION HISTORICAL INVENTORY OF SOLID WASTE DISPOSAL SITES 1987.

STS Consultants Ltd.
Consulting Engineers

HAZARDOUS WASTE FACILITIES LOCATED IN U.S. POSTAL ZIP CODE AREA
60601, 60602, 60603, 60604, 60606
60611 AND PORTIONS OF 60610

DRAWN BY	DATE	SCALE	STS PROJECT NO
KKB	7-15-92	SHOWN	27313-XH
CHECKED BY	DATE	SHEET NO	STS FILE NO
DLG	7-15-92		27313-XH

FIGURE 6

ALL LOCATIONS ARE APPROXIMATE

STS Consultants Ltd.

CLIENT	LOG OF BORING NUMBER
Power/CRSS	B-106
PROJECT NAME	ARCHITECT-ENGINEER
Northwestern Memorial Hospital	Ellerbe Beckett/HOK

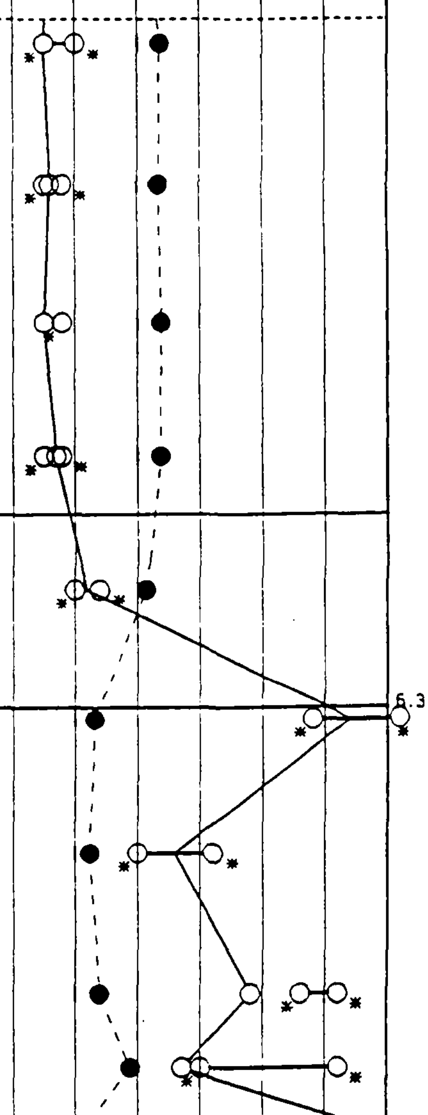
SITE LOCATION
Grand/Columbus/Illinois/McClurg Ct.: Chicago, Illinois

UNCONFINED COMPRESSIVE STRENGTH TONS/FT.^{2} — 1 2 3 4 5

PLASTIC LIMIT % — WATER CONTENT % — LIQUID LIMIT % — 10 20 30 40 50

STANDARD PENETRATION BLOWS/FT. — 10 20 30 40 50

DEPTH (FT)	ELEVATION (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DISTANCE	RECOVERY	DESCRIPTION OF MATERIAL	UNIT DRY WT. LBS./FT.^{3}	PHOTO-IONIZATION DETECTOR READING (PPM)
						SURFACE ELEVATION		
						Continued from previous page		
40.0		10	ST			Silty clay, trace gravel, sand and shale - gray - medium (CL)	106	
			RB					
			VS			Field vane at 42.5 ft. $s_u = 1319$ psf		
			RB					
45.0		11	ST				108	
			RB					
			VS			Field vane at 47.5 ft. $s_u = 1066$ psf		
			RB					
50.0		12	ST				107	
			RB					
55.0		13	ST				106	
			RB			Silty clay, trace gravel, sand and shale - gray - stiff (CL)		
60.0		14	ST					
			RB					
65.0		15	ST			Silty clay, trace gravel, sand and shale - gray - very stiff to hard (CL)		
			RB					
70.0		16	ST					
			RB					
75.0		17	ST				123	
			RB					
		18	ST				112	
80.0			RB					



* Calibrated Penetrometer

.. continued

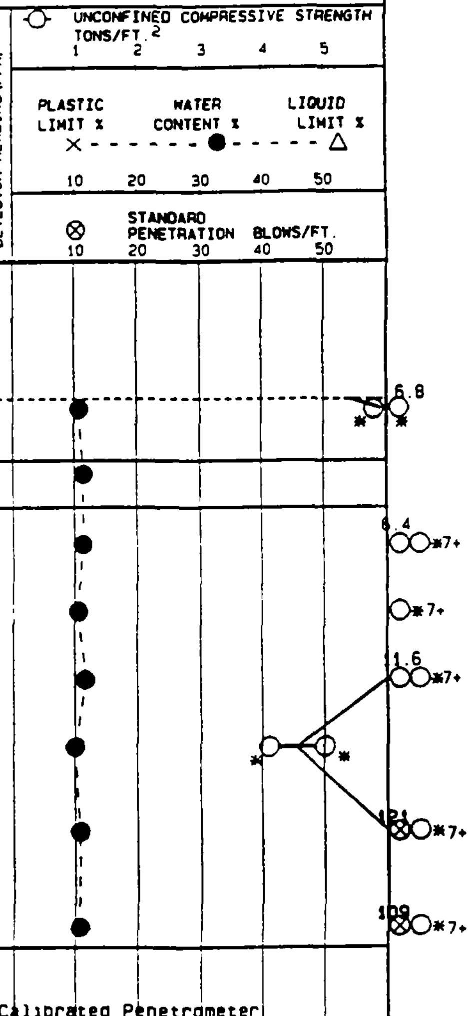
The stratification lines represent the approximate boundary lines between soil types: in-situ, the transition may be gradual.

STS JOB NO. 27313 | SHEET NO. 2 OF 3

STS Consultants Ltd.	CLIENT: Power/CRSS	LOG OF BORING NUMBER: B-106
	PROJECT NAME: Northwestern Memorial Hospital	ARCHITECT-ENGINEER: Ellerbe Beckett/HOK

SITE LOCATION
Grand/Columbus/Illinois/McClurg Ct.: Chicago, Illinois

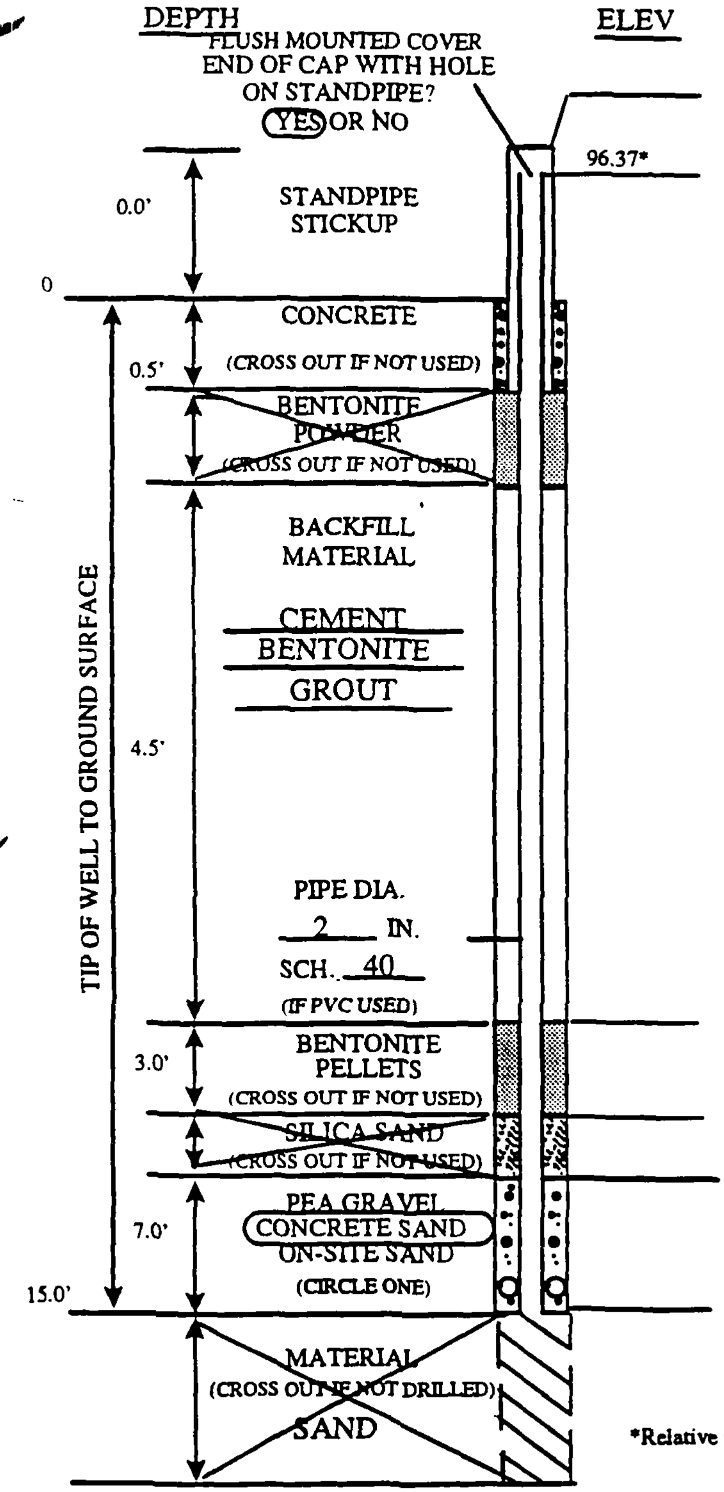
DEPTH (FT)	ELEVATION (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DISTANCE	RECOVERY	DESCRIPTION OF MATERIAL (SURFACE ELEVATION)	UNIT DRY WT. LBS./FT.^{3}	PHOTO-IONIZATION DETECTOR READING (PPM)
						Continued from previous page		
80.0		19	ST			Silty clay, trace gravel, sand and shale - gray - very stiff to hard (CL)		
			RB					
		20	ST			Clayey silt, little sand, trace gravel - gray - moist (ML)		
			RB					
85.0		21	ST			Silty clay, little sand, trace gravel and shale - gray - hard (CL)	131	
			RB					
		22	ST				132	
			RB					
90.0		23	ST					
			RB					
		24	ST					
			RB					
95.0		25	SS					
			RB					
		26	SS					
100.0						End of Boring Borehole grouted upon completion. Casing used 35 ft. of 4 in.		



The stratification lines represent the approximate boundary lines between soil types: in-situ, the transition may be gradual.

WL	WS OR WD	BORING STARTED 07/17/92	STS OFFICE Northbrook-01	
WL	BCR ACR	BORING COMPLETED 07/22/92	ENTERED BY KKB	SHEET NO. 3 OF 3
WL		RIG/FOREMAN B-61/DT	APP'D BY MAK	STS JOB NO. 27313

STS Field Well Installation Diagram



1) TYPE OF PIPE
PVC, GALVANIZED, STAINLESS, OTHER ______

2) TYPE OF PIPE JOINTS
BELLED, COUPLINGS, THREADED, OTHER ______

3) TYPE OF WELL SCREEN
PVC, GALVANIZED, STAINLESS, OTHER ______

4) SCREEN SLOT SIZE 0.01 inches

5) SCREEN LENGTH 5 feet

6) INSTALLED PROCTECTOR PIPE W/LOCK? YES OR NO

7) DRILLING METHOD Solid Stem Augers
DRILLING FLUID Water
BOREHOLE DIAMETER 4 inches

8) BACKFILL MATERIAL INSTALATION FROM
SURFACE, TREMIE

9) HOW WAS WELL DEVELOPED?
BAILING, PUMPING, SURGING, COMPRESSED AIR

10) APPROXIMATE WATER VOLUME REMOVED OR ADDED?
5 GAL, 10 GAL, 15 GAL, OTHER 4 gals

11) WATER CLARITY BEFORE DEVELOPMENT
CLEAR, TURBID, OPAQUE

12) WATER CLARITY AFTER DEVELOPMENT
CLEAR, TURBID, OPAQUE

13) DID THE WATER SMELL? YES OR NO

14) WATER LEVEL SUMMARY
1) DEPTH FROM T. STANDPIPE AFTER DEVELOPMENT?
13 feet FT OR DRY
2) OTHER MEASUREMENTS: SEE OBSERVATION WELL SUMMARY
DATE 9/11/92, 11.09 FT FROM T. ST. PIPE
DATE ______, ______ FT FROM T. ST. PIPE
DATE ______, ______ FT FROM T. ST. PIPE
DATE ______, ______ FT FROM T. ST. PIPE

*Relative to benchmark elevation = 100.00 feet

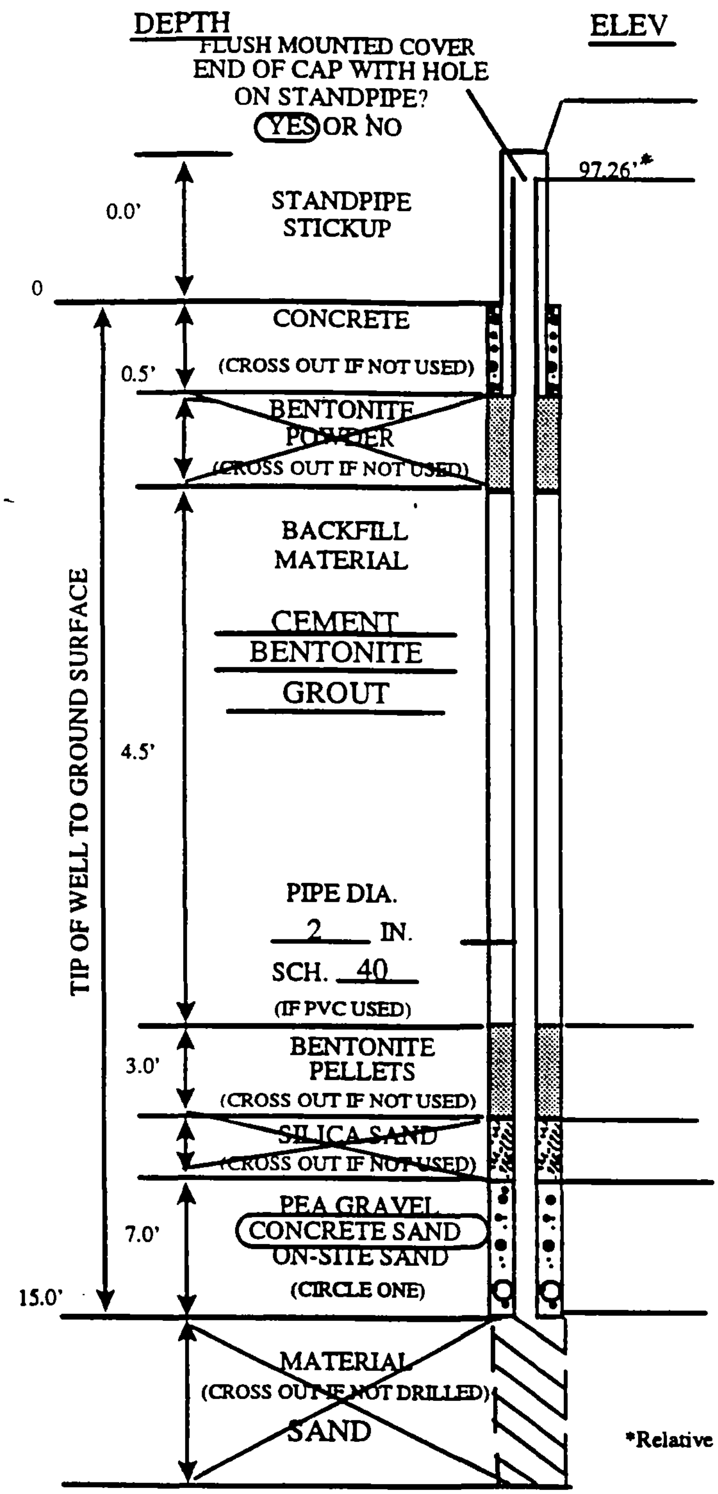
WELL NO. MW-128 DATE INSTALLED 9/5/92 DRILL RIG DR-9

DRILLER Dumas DRILL CREW Deon

JOB/CLIENT Proposed NWMH Facility Redevelopment Site/Power/CRSS STS PROJECT NO. 27313-XH

(Power/CRSS_mw-128/m11draw/nt) (VERSION 3: 08/91 - M11DRAW "FIELD_WELL_KAS")

STS Field Well Installation Diagram



1) TYPE OF PIPE
PVC, GALVANIZED, STAINLESS, OTHER ______

2) TYPE OF PIPE JOINTS
BELLED, COUPLINGS, THREADED, OTHER ______

3) TYPE OF WELL SCREEN
PVC, GALVANIZED, STAINLESS, OTHER ______

4) SCREEN SLOT SIZE 0.01 inches

5) SCREEN LENGTH 5 feet

6) INSTALLED PROCTECTOR PIPE W/LOCK? YES OR NO

7) DRILLING METHOD Solid Stem Augers
DRILLING FLUID Water
BOREHOLE DIAMETER 4 inches

8) BACKFILL MATERIAL INSTALATION FROM
SURFACE, TREMIE

9) HOW WAS WELL DEVELOPED?
BAILING, PUMPING, SURGING, COMPRESSED AIR

10) APPROXIMATE WATER VOLUME REMOVED OR ADDED?
5 GAL, 10 GAL, 15 GAL, OTHER 4 gals

11) WATER CLARITY BEFORE DEVELOPMENT
CLEAR, TURBID, OPAQUE

12) WATER CLARITY AFTER DEVELOPMENT
CLEAR, TURBID, OPAQUE

13) DID THE WATER SMELL? YES OR NO

14) WATER LEVEL SUMMARY

1) DEPTH FROM T. STANDPIPE AFTER DEVELOPMENT?
13 feet FT OR DRY

2) OTHER MEASUREMENTS: SEE OBSERVATION WELL SUMMARY

DATE 9/11/92, 12.85 FT FROM T. ST. PIPE
DATE ______, ______ FT FROM T. ST. PIPE
DATE ______, ______ FT FROM T. ST. PIPE
DATE ______, ______ FT FROM T. ST. PIPE

*Relative to benchmark elevation = 100.00 feet

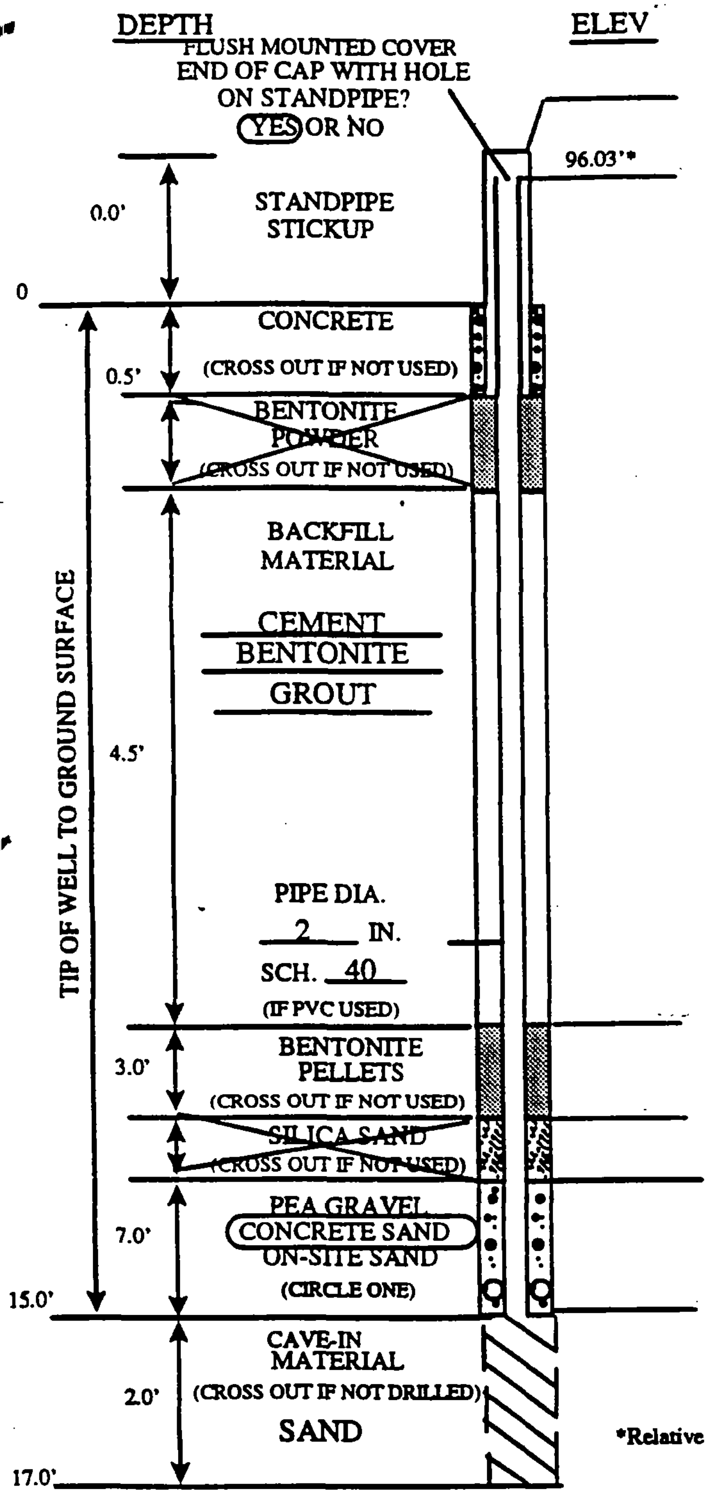
WELL NO. MW-129 DATE INSTALLED 9/5/92 DRILL RIG DR-9

DRILLER Dumas DRILL CREW Deon

JOB/CLIENT Proposed NWMH Facility Redevelopment Site/Power/CRSS STS PROJECT NO. 27313-XH

(Power/CRSS_mw-129/m11draw/nt) (VERSION 3: 08/91 - M11DRAW "FIELD_WELL_KAS")

STS Field Well Installation Diagram



1) TYPE OF PIPE
PVC, GALVANIZED, STAINLESS, OTHER ________

2) TYPE OF PIPE JOINTS
BELLED, COUPLINGS, THREADED, OTHER ________

3) TYPE OF WELL SCREEN
PVC, GALVANIZED, STAINLESS, OTHER ________

4) SCREEN SLOT SIZE 0.01 inches

5) SCREEN LENGTH 5 feet

6) INSTALLED PROCTECTOR PIPE W/LOCK? YES OR NO

7) DRILLING METHOD Solid Stem Augers
DRILLING FLUID None
BOREHOLE DIAMETER 4 inches

8) BACKFILL MATERIAL INSTALATION FROM
SURFACE, TREMIE

9) HOW WAS WELL DEVELOPED?
BAILING, PUMPING, SURGING, COMPRESSED AIR

10) APPROXIMATE WATER VOLUME REMOVED OR ADDED?
5 GAL, 10 GAL, 15 GAL, OTHER 4 gals

11) WATER CLARITY BEFORE DEVELOPMENT
CLEAR, TURBID, OPAQUE

12) WATER CLARITY AFTER DEVELOPMENT
CLEAR, TURBID, OPAQUE

13) DID THE WATER SMELL? YES OR NO

14) WATER LEVEL SUMMARY
1) DEPTH FROM T. STANDPIPE AFTER DEVELOPMENT?
12.0 FT OR DRY
2) OTHER MEASUREMENTS: SEE OBSERVATION WELL SUMMARY
DATE 9/11/92, 11.87 FT FROM T. ST. PIPE
DATE ________, ________ FT FROM T. ST. PIPE
DATE ________, ________ FT FROM T. ST. PIPE
DATE ________, ________ FT FROM T. ST. PIPE

*Relative to benchmark elevation = 100.00 feet

WELL NO. MW-130 DATE INSTALLED 9/5/92 DRILL RIG DR-9

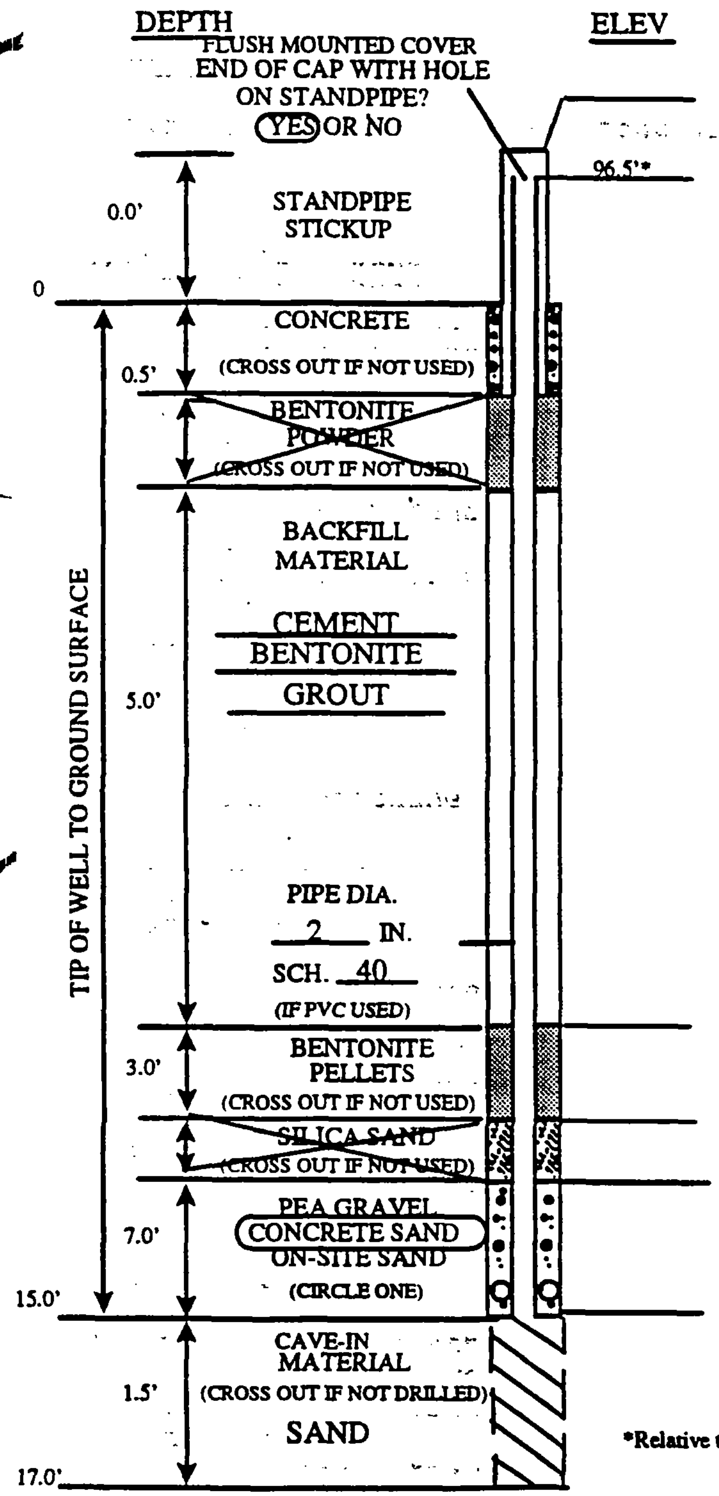
DRILLER Dumas DRILL CREW Deon

JOB/CLIENT Proposed NWMH Facility Redevelopment Site/Power/CRSS STS PROJECT NO. 27313-XH

(POWER/CRSS_MW-130/M11DRAW/NT) (VERSION 3: 08/91 - M11DRAW "FIELD_WELL_KAS")

STS Field Well Installation Diagram

Page 2 of 8



1) TYPE OF PIPE
PVC, GALVANIZED, STAINLESS, OTHER ______

2) TYPE OF PIPE JOINTS
BELLED, COUPLINGS, THREADED, OTHER ______

3) TYPE OF WELL SCREEN
PVC, GALVANIZED, STAINLESS, OTHER ______

4) SCREEN SLOT SIZE 0.01 inches

5) SCREEN LENGTH 5 feet

6) INSTALLED PROCTECTOR PIPE W/LOCK? YES OR NO

7) DRILLING METHOD Solid Stem Augers
DRILLING FLUID None
BOREHOLE DIAMETER 4 inches

8) BACKFILL MATERIAL INSTALATION FROM
SURFACE, TREMIE

9) HOW WAS WELL DEVELOPED?
BAILING, PUMPING, SURGING, COMPRESSED AIR

10) APPROXIMATE WATER VOLUME REMOVED OR ADDED?
5 GAL, 10 GAL, 15 GAL, OTHER 4 gals

11) WATER CLARITY BEFORE DEVELOPMENT
CLEAR, TURBID, OPAQUE

12) WATER CLARITY AFTER DEVELOPMENT
CLEAR, TURBID, OPAQUE

13) DID THE WATER SMELL? YES OR NO

14) WATER LEVEL SUMMARY
1) DEPTH FROM T. STANDPIPE AFTER DEVELOPMENT?
13 FT OR DRY
2) OTHER MEASUREMENTS: SEE OBSERVATION WELL SUMMARY
DATE 9/11/92 , 12.22 FT FROM T. ST. PIPE
DATE ____ , ____ FT FROM T. ST. PIPE
DATE ____ , ____ FT FROM T. ST. PIPE
DATE ____ , ____ FT FROM T. ST. PIPE

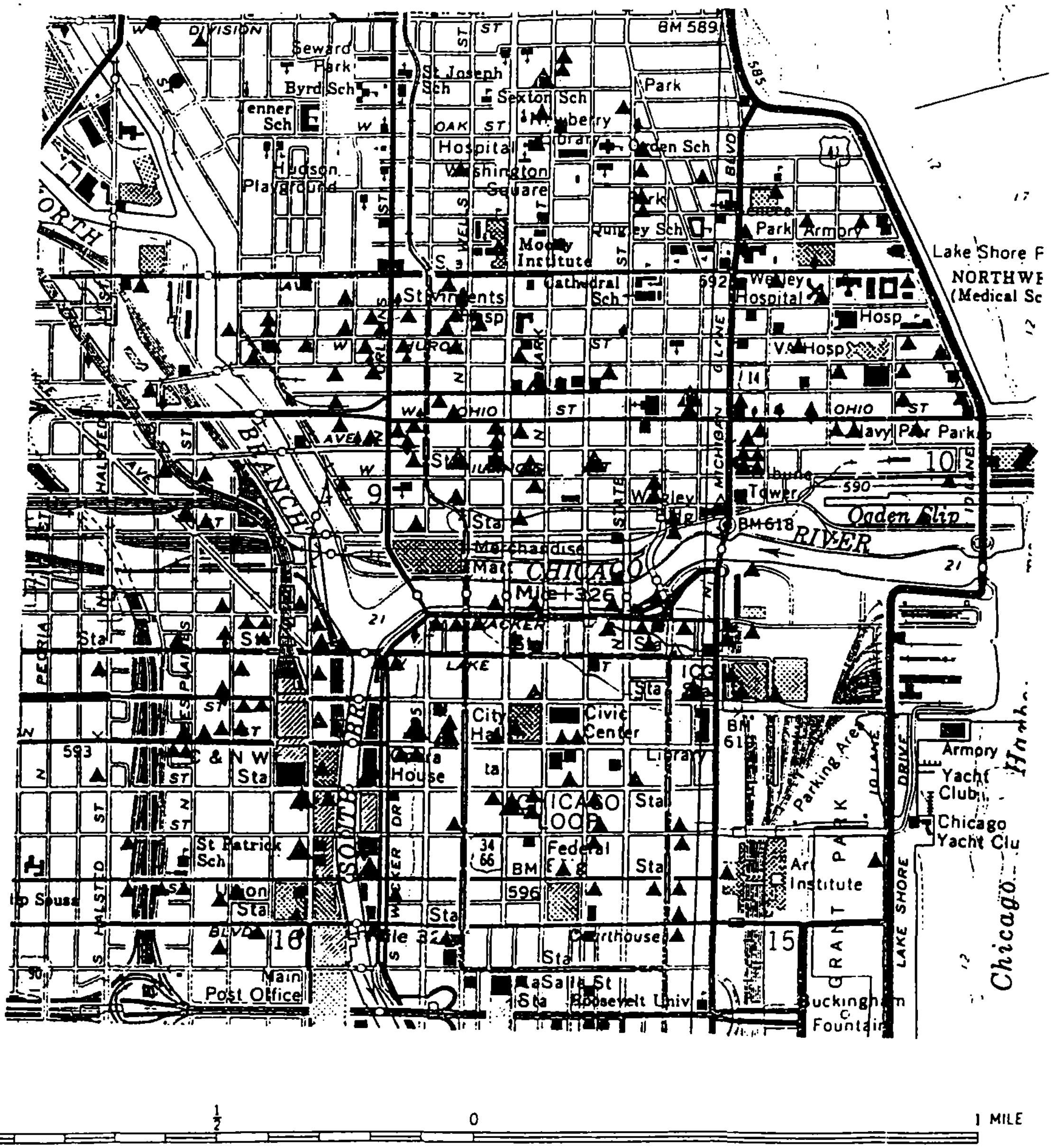
*Relative to benchmark elevation = 100.00 feet

WELL NO. MW-131 DATE INSTALLED 9/5/92 DRILL RIG DR-9

DRILLER Dumas DRILL CREW Deon

JOB/CLIENT Proposed NWMH Facility Redevelopment Site/Power/CRSS STS PROJECT NO. 27313-XH

(POWER/CRSS_MW-131/M11DRAW/NT) (VERSION 3: 08/91 - M11DRAW "FIELD_WELL_KAS")



REF. BASE MAP: USGS QUADRANGLE MAP
7.5 MINUTE SERIES (TOPOGRAPHIC)
CHICAGO LOOP
PHOTOREVISED 1972

N

LEGEND

SITE

- ● CERCLIS SITES
- ▲ RCRA GENERATORS AND[1] TSDS FACILITIES
- ■ UST SITES[2]
- ♦ LUST SITES[3]
- SOLID WASTE DISPOSAL SITES[4]

LEGEND

1. USEPA COMPUTER DATA BASE SEARCH DATED 5-21-91.
2. ILLINOIS STATE FIRE MARSHALL UNDERGROUND STORAGE TANKS (UST) DATA BASE 5-2-90.
3. ILLINOIS STATE FIRE MARSHALL LIST OF LEAKING UNDERGROUND STORAGE TANKS (LUST) INCIDENTS REPORT 5-1-91.
4. NORTHEASTERN ILLINOIS PLANNING COMMISSION HISTORICAL INVENTORY OF SOLID WASTE DISPOSAL SITES 1987.

STS Consultants Ltd.
Consulting Engineers

HAZARDOUS WASTE FACILITIES
LOCATED IN U.S. POSTAL ZIP CODE AREA
60601, 60602, 60603, 60604, 60606
60611 AND PORTIONS OF 60610

FIGURE 6

ALL LOCATIONS ARE APPROXIMATE

DRAWN BY	DATE	SCALE	STS PROJECT NO
KKB	7-15-92	SHOWN	27313-XH
CHECKED BY	DATE	SHEET NO	STS FILE NO.
DLG	7-15-92		27313-XH